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EXPERIMENTS IN SHELTERING IN PLACE: HOW FILTERING AFFECTS PROTECTION AGAINST SARIN AND MUSTARD VAPOR

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13. ABSTRACT *(Maximum 200 words)*
A two-room cottage of conventional wooden construction was subjected to a series of transient vapor challenges with sarin, mustard, and methyl salicylate (a simulant for mustard) to measure the protection afforded by sheltering in place. The purpose of the experiments was to determine how sorption of the agent by the shell and interior surfaces of the building (passive filtering) affects protection. Experiments also measured the improvement in protection attainable by operating a consumer type indoor air purifier (with a carbon filter) in the cottage during and after the challenge. Sorption of agent vapor was found to produce substantially higher protection factors than are predicted simply by air exchange. In hour-long challenges with mustard vapor, passive filtering increased the protection provided by the cottage by a factor ranging from 15 to 50. Increases in protection factor were significant with sarin, the more volatile agent, but substantially less than were seen with mustard. Use of an indoor air purifier of 350 cfm resulted in a doubling of protection factors achieved by this cottage.

14. SUBJECT TERMS

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PREFACE

The work described in this report was funded by the Chemical Stockpile Emergency Preparedness Program. This study was started in February 1996 and completed in February 1999.

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CONTENTS

FIGURES

TABLES

Experiments in Sheltering in Place: How Filtering Affects Protection Against Sarin and Mustard Vapor

1. INTRODUCTION

Sheltering in place is a means of protecting the public when an accidental release of hazardous chemicals occurs. In recent years, this has become a widely accepted alternative to evacuation, mainly because it can be implemented more rapidly than evacuation. Procedures for sheltering in place have been published and implemented by several communities and organizations in the U.S.

To shelter in place is to apply the passive protection a building provides against airborne contaminants, maximizing such protection for relatively short periods by closing windows, vents, and doors and turning off heating, ventilating, and air conditioning (HVAC) systems before the plume of hazardous chemical arrives. Expedient measures such as applying tape around doors and placing plastic sheeting over windows can increase this protection by reducing the rate of air exchange between the interior and exterior of the building.

Even tightly sealed, a building does not prevent contaminated air from entering; rather, it minimizes the rate of infiltration to provide short-term protection. Contaminated air enters at a slow rate, and once the hazardous cloud has passed, the closed building slowly releases the contaminated air. Because of this slow release, the procedure for attaining maximum protection is to open all windows and doors and exit the building as soon as the hazardous cloud has passed.

Sheltering in place has been evaluated as a protective measure for application under the Chemical Stockpile Emergency Preparedness Program (CSEPP), the charter of which is to ensure public safety in the communities near the eight U.S. Army chemical weapons storage and demilitarization sites. The chemical warfare agents stored for disposal at these sites are nerve agents sarin (GB) and VX, and the blister agent mustard (HD). To support the evaluation of sheltering in place, the Respiratory and Collective Protection Team of the U.S. Army Edgewood Research, Development and Engineering Center (ERDEC)*in 1995 reviewed the literature and conducted experiments to evaluate methods for expedient sheltering.[1] This effort resulted in recommendations to acquire estimates of the effects of the passive and active filtering upon protection.

Passive filtering occurs as materials in the building shell and interior surfaces absorb or adsorb chemical vapors/gases as the contaminated air passes through the building. Active filtering involves the use of a forced-air filtration unit with an adsorber (carbon) bed. The recommendation of the 1996 report with regard to active filtering was to evaluate the use of consumer-type indoor air purifiers for increasing the protection attainable by sheltering in place.

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2. OBJECTIVES

This study had two objectives:

To estimate the extent to which passive filtering increases the protection afforded by sheltering in place against the toxic chemical agents of the chemical stockpile.

To estimate the gains in protection attainable by applying low-cost active filtering--use of a consumer-type indoor air purifier with carbon filter--while sheltering in a selected safe room.

3. SCOPE AND LIMITATIONS

This study consisted of 29 experiments conducted over a period of 18 months on a two-room cottage of conventional frame construction measuring 8 ft by 12 ft with a 7 ft ceiling. In each experiment, the cottage was exposed to transient (1-hr duration), uniform vapor concentration of chemical agent or simulated chemical agent. Results of 24 of these experiments are reported here:

- Eighteen experiments with the mustard simulant methyl salicylate (MS) to examine passive and active filtering. Most of these involved the use of a consumer type indoor air purifier with a carbon filter element in one room of the cottage to evaluate a low-cost approach to active filtering.

- Three experiments with the nerve agent GB, the most volatile of the U.S. stockpile agents, at a concentration of 5 to 7 g/m^3 to examine passive filtering.

- Three experiments with HD vapor, a less volatile agent of the stockpile, at a concentration of 5 to 7 mg/m^3 to examine passive filtering.

The cottage was also exposed to three other 1-hour GB challenges of about 5 mg/m^3 and two other MS challenges of about the same dosage. These are not reported here because of air sampling difficulties.

Agent vapors were sampled on several occasions between and after the experiments with GB and to HD to determine whether residual concentrations of agent remained in the cottage.

The natural air exchange rate of the cottage was measured on 10 occasions with the non-depositing tracer gas sulfur hexafluoride (SF_6). The approach in quantifying the passive filtering was to use as a basis the protection factor calculated with the natural air exchange rate and a 1-hour exposure. The natural air exchange rate was determined by measuring the rate of concentration change of the SF_6 released internally.

All experiments, including the tracer gas measurements, were made with the cottage indoors with a small temperature difference between the interior and exterior of the cottage. Such conditions were selected to minimize variability associated with convective transport.

This approach yields higher protection factors than would be achieved in normal conditions (in which wind and inside-outside temperature difference induce infiltration) and can be considered to represent the maximum possible protection factors for the given structure. A small temperature difference approximates the condition of having the HVAC system turned off, and it is the condition likely to produce the greatest amount of filtering. In the six experiments with GB and HD, the inside-outside temperature difference was greater, up to 25°F, as the result of heat generated by an air sampling vacuum pump inside the cottage (the pump was outside the cottage in the MS experiments).

The air exchange rate of the cottage was varied to a limited degree in two ways: by having two rooms of different configuration and by varying (in MS trials only) the expedient sealing measures to the rooms with duct tape and polyethylene sheeting over intentional openings.

Air exchange rate measurements were also made by fan-pressurization testing, the method employed most widely in surveying residential buildings. These measurements, made at 50 Pa (0.2 inches water gage), were taken to determine the tightness of the cottage relative to the range of U.S. residential buildings. There were some variations in these measurements over time, probably the result of moisture changes of the wood with the seasons.

A transient challenge concentration was achieved in the MS experiments by rolling the cottage into and out of the test chamber. This approach was taken to prevent the residual MS concentrations in the chamber (resulting from vapor absorbed by chamber walls) from affecting post-exposure samples. Due to safety constraints, this approach was not possible in the GB and HD challenges. In the GB and HD experiments, the challenge cloud was dissipated rapidly by high-volume purge fans.

Repeated challenges of the same cottage were made under the assumption that the sorptive capacity of the cottage would not change during these experiments.

4. BACKGROUND

4.1 How Protection is Achieved by Sheltering in Place.

Protection against airborne contaminants is commonly defined in terms of protection factor, the ratio of dosage outside a protective enclosure to the dosage inside. Dosage equals concentration integrated over time and is usually stated as mg-min/m^3. When concentration is constant, dosage is equal to the concentration multiplied by the time of exposure.

The protection provided by sheltering in place is governed by four variables:

- **Air exchange rate of the building/room.** All buildings have air leakage, an exchange of air between the indoors and outdoors through cracks, pores, or other openings. This rate is expressed relative to the volume of the building as air changes per hour (ACH). The lower the air exchange rate, the greater is the protection afforded.

• **Passive filtering efficiency.** Passive filtering occurs when the chemical vapor/gas is removed from the air by absorption or adsorption as it infiltrates through cracks and pores and comes in contact with materials inside the building. Buildings are not considered to be highly efficient filters, and filtering has been neglected in estimates of protection because there has been little data on which to base such estimates.

• **Duration of exposure.** The protection provided by a passive shelter varies with time. It diminishes as the time of exposure increases; therefore, sheltering in place is most effective against hazards of short duration. If the effect of filtering is neglected, the protection factor approaches 1 (no protection) as the duration of exposure becomes long.

• **Period of occupancy.** How long occupants remain in the building after the hazardous cloud has passed affects the protection they receive. Because the building slowly releases contaminants that have infiltrated, at some point during cloud passage the concentration inside exceeds the concentration outside. Maximum protection is attained by exiting the building into a clean environment and/or by increasing the air change rate after cloud passage by opening windows and doors.

The relationship of these variables, except for filtering, is described by the equation below. Its derivation is found in several references, such as reports by Engelmann[2] and Lewis[3]. Here R is the air exchange rate of the building in air changes per hour; T is the time the building is exposed to the hazardous cloud, in hours; and t is the time of occupancy, in hours, beginning upon arrival of the hazardous cloud. This equation was applied in this study to determine the basis for the effect of filtering.

$$\text{Protection Factor} = \frac{RT}{RT + e^{-Rt} - e^{R(T-t)}}$$

4.2 Passive Filtering.

A building filters vapors/gases from the air passing through it by both adsorption, the physical condensation on a solid substrate, and absorption, the permeation of the agent into the molecular structure of the material. For simplicity, the two processes together can be referred to as sorption. Desorption, the release of the agent from the material, may also occur within the period of interest as ambient vapor concentration decreases.

Studies by Engelmann[2], Birenzvige[4], and Stearman[5] indicate that the effect of filtering can be substantial; however, their quantitative estimates are based upon little or no empirical data on the rates of sorption and desorption of chemical vapors.

There are two distinct components of the filtering that occurs in a building. One is filtering by the shell--sorption of agent as the contaminated air passes through cracks and pores of the building walls, ceiling, or floor. The other is sorption upon internal surfaces, which occurs as the contaminated air resides in the building. These have been referred to as the external filtering and internal filtering, respectively, and they are assumed to have different rates and efficiencies.

Filtering is governed by the residence time (a function of flow velocity and path length), the sorbent surface area along the flow path, and the characteristics of the sorbent material and agent. Filtration is most efficient when flow paths are long and narrow, have large exposed surface areas, and contain materials with a large sorptive capacity for the particular agent.

Thus the efficiency with which a building filters a chemical vapor varies with the air exchange rate of the building. The tighter the building shell, the narrower and longer are its leakage paths and the longer is the residence time of the vapor in the building.

The rate at which sorption occurs depends upon the chemical and physical characteristics of both the sorbent material and the vapor, as well as the exposed surface area of the material. Generally, the rate of sorption varies inversely with the volatility of the agent. The limited experimental work to measure the rates of filtering with agents has focused on the internal filter factor, measuring the deposition velocity of the agent on the walls of a test chamber. A model developed by Karlsson[6] based upon an internal release in a chamber showed that GB, the most volatile of the stockpile agents, has a very high deposition rate on unpainted concrete and a low desorption rate from it.

4.3 **Active Filtering.**

Active filtering involves the use of a fan to force air through bed of sorbent material such as activated carbon. There are two methods of applying active filtering. One is to force outside air through the filter bed and into the enclosure at a rate sufficient to produce an over-pressure. This provides positive-pressure collective protection, which can yield very high protection factors, typically in the range of 10,000 to 100,000 as limited by the efficiency of the carbon filter. The second is to draw air from the interior, through the filter and discharge it to the interior. This method, which produces no change in the internal pressure of the enclosure, is referred to as recirculation filtering.

The advantage of positive pressure collective protection is that it prevents infiltration by producing an outward flow of clean air through leakage paths. If the over-pressure is adequate to overcome convective forces, very high protection factors can be achieved; however, this type of protection is expensive.

Recirculation filtering removes the contaminants once they have entered and therefore yields protection factors that are lower than those achievable with positive pressure. In sheltering, the protection afforded by recirculation filtering is a function of the infiltration rate of the enclosure, the passive removal efficiency of the enclosure, the volume of the enclosure, the flow rate of the filter unit, and the removal efficiency of the unit.

Recirculation filtering is inexpensive and it can be applied to a safe room for sheltering without permanent modifications. Recirculation filtering is the only method of active filtering evaluated in this study. Its application is addressed here in specific terms by measuring the protection factors obtained with a consumer type unit currently on the market. After a market survey, several units containing an activated carbon filter (in

addition to a particulate filter) were purchased and evaluated for removal efficiency, flow rate, and carbon filter capacity. Among these, only the unit found to provide the best performance was tested in the cottage.

Consumer-type indoor air purifiers do not contain impregnated carbon; therefore, they filter only by physical adsorption and remove only chemical compounds of vapor pressure less than about 10 mm Hg at the temperature of the filter bed. Because the agents of the U.S. chemical weapons stockpile have vapor pressures well within this range, they can be removed by these filter units. Industrial chemicals of higher vapor pressure, such as chlorine, cannot be removed by such units.

5. DESCRIPTION OF THE TEST COTTAGE

Figure 1 shows the cottage (8 ft by 12 ft with a 7-ft wall height) on which all experiments were conducted. The cottage was of conventional construction with 2x4 framing on 16-inch centers. Interior walls and ceilings were of gypsum wall board taped, sanded, and finished with semi-gloss latex paint. Standard fiberglass insulation was applied except for the wall between the two rooms and above the ceiling. Flooring was 5/8-in. exterior-grade plywood with a vinyl floor covering. Baseboard moulding was applied to all walls. Floor joists were also of 2x4 lumber spaced on 16-inch centers.

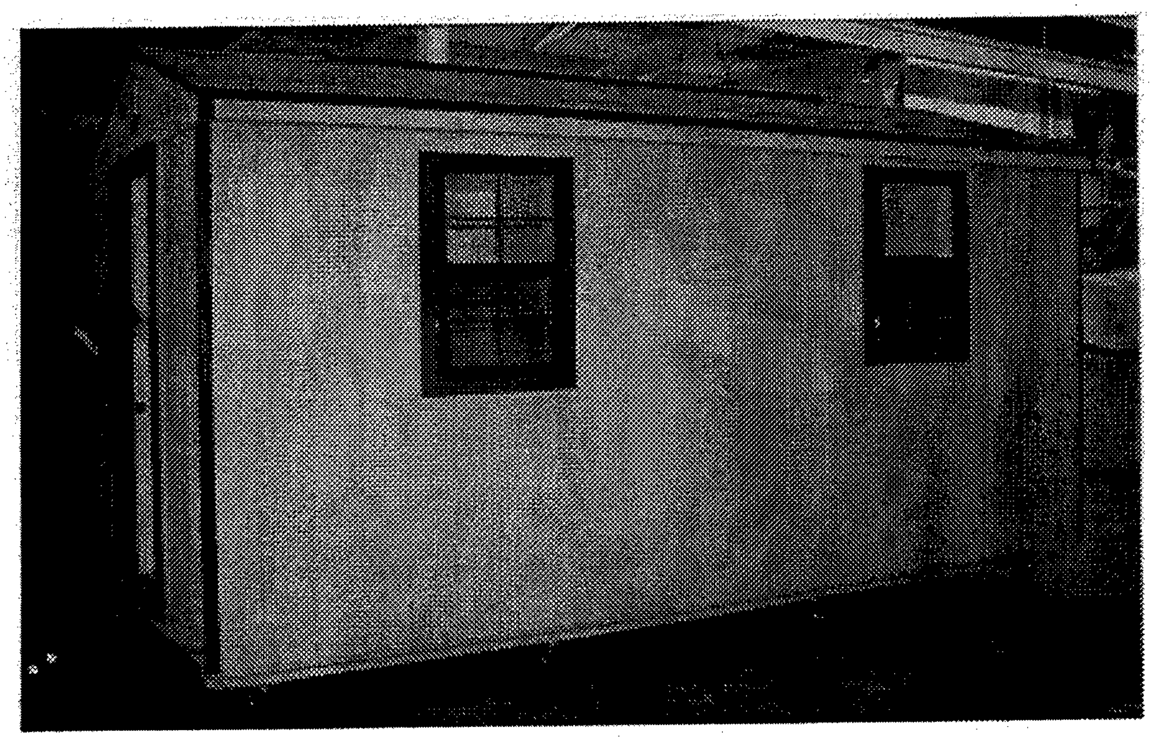

Figure 1. The Cottage on which All Experiments Were Conducted

The cottage was divided into two rooms of equal size, each 6 ft by 8 ft. Each of the two rooms had one door to the outside, and there was no door or any penetration of the wall between the two rooms. The doors were metal with weather stripping around the periphery of each. There were three double-hung aluminum windows. One room, designated room No. 1 had one window and the other, room No. 2, two windows. Each room had one electrical outlet in an outside wall, and one combination ceiling fixture containing a light and an exhaust fan ducted outside with a flapper valve. One 4-inch hole was cut through the center of each door, to which was mounted a flanged duct adapter for use in fan-pressurization testing and for routing cables out of the cottage. During the experiments, these ports were sealed with duct tape and duct seal. The cottage was mounted on three 4x4 beams to which were attached wheels for movement into and out of the test chamber.

5.1 Expedient Sealing Measures Applied to the Cottage.

In some of the experiments, the air exchange rate of the rooms was reduced through expedient sealing techniques identified in a study by the Oak Ridge National Laboratory:[7] taping low-density polyethylene sheeting over windows and vents and applying duct tape around each door. Polyethylene sheeting was also taped over the exhaust fan in each room. The three levels of sealing were: none, full, and partial. For the partially sealed condition, only one of the two windows of room no. 2 was covered with polyethylene sheet. Measurements of the air exchange rate were made for each of these levels of sealing and were used in the calculating the protection factor based on air exchange alone.

5.2 Air Exchange Rates of the Cottage in Various Configurations.

Air exchange rate of the cottage was measured by tracer gas dilution per American Society of Testing and Materials (ASTM) E741, "Standard Test Methods for Determining Air Change in a Single Zone by Means of Tracer Gas Dilution". Measurements by this method, summarized in Table 1, were used to calculate the protection factor of the cottage without the effect of filtering. These measurements were taken under the same conditions as the challenge tests, that is, small temperature differential and no wind.

To examine the cottage's air leakage characteristics, measurements were also made by the fan-pressurization method per ASTM 779, "Test Method for Determining Air Leakage Rate by Fan Pressurization." Table 2 lists the values measured with a Code Tester by the fan pressurization method in April 1997. Measurements taken at other times are shown in Appendix A. Measurements made near the beginning of this study showed that the unsealed cottage had mean leakage rates of 90.2 cfm for room 1 and 109.6 cfm for room 2 at 50 Pa. This was based upon measurements of 106.4, 113.1, and 109.4 cfm at on room 2 on 3 June, 5 June, and 15 July 96 respectively Measurements of room 1 were 95.7, 92.7, 87.3, and 85.6 cfm at 50 Pa made on 30 May, 6 June, and 15 July 96 respectively.

To compare the air tightness of the cottage to that of the average house, the fan-pressurization measurements at 50 Pa in the unsealed configuration were applied in the commonly used formula for roughly relating fan-pressurization measurements to natural air

exchange rate. ACH_{50} is calculated by dividing the air exchange rate at 50 Pa by 20. For the room with one window, this value was 0.80. For the room with two windows, it was 0.98. These values compare with the mean ACH_{50} of 1.5 ACH determined in a sample of 12,900 U.S. houses by Sherman and Dickerhoff.[8]

Table 1. Measurements of Natural Air Exchange Rate of Cottage Using SF_6

Date of Measurement	Room 1 Configuration	Room 1 Air changes/hr	Room 2 Configuration	Room 2 Air changes/hr
24 May 96	Exhaust fan taped	0.052	No sealing	0.165
28 May 96	No sealing	0.086	Exhaust fan taped	0.098
21 June 96	Full sealed*	0.057	Fully sealed	0.042
1 July 96	Exhaust fan taped	0.048	Fully sealed	0.052
9 July 96	Exhaust fan taped	0.036	Fully sealed	0.051
9 July 96	Fully sealed	0.047	No sealing	0.120
12 July	Exhaust fan taped	0.038	Vent, 1 window taped	0.089
22 July 96	Exhaust fan taped	0.051		
23 July 96	Fully sealed	0.030	Fully sealed	0.038
6 Aug 97	Exhaust fan taped	0.046	Exhaust fan taped	0.105

* Fully sealed indicates window(s) covered with polyethylene sheet and taped, ceiling exhaust fan taped, and tape applied around the periphery of the door.

If the leakage through the duct of the ceiling exhaust fan was eliminated by sealing the fan, the ACH_{50} for the two rooms was reduced to 0.37 ACH for room 1 and 0.46 ACH for room 2. Temporal variations were apparent in the air exchange rate, a probable result of relative humidity causing changes in moisture content of the wood.

6. CHEMICAL AGENTS AND SIMULANTS

Methyl salicylate (MS) was used as the simulated chemical agent (simulant) in 18 of the experiments. Also known as oil of wintergreen, MS has been used as a simulant for mustard in chemical warfare testing for over 50 years. It has vapor pressure similar to mustard and has been shown to be similar to mustard in the sorption of its vapor by clothing.[9] A comparison of the vapor pressures of MS, HD, and GB is shown below. VX, the stockpile agent not tested in this series, has a far lower vapor pressure of 0.0007 mm Hg at 25°C.

Sarin (GB)	2.9 mm Hg at 25°C
Mustard (HD)	0.072 mm Hg at 20°C.
Methyl salicylate (MS)	0.091 mm Hg at 20°C

The MS used in all experiments was of 98% purity. In the toxic agent challenges, the GB was of purity of 98.7% (from lot no. GB-U-6184-CTF-N), and the HD of purity 97.5% (lot no. HD-U-2325-CTF-N).

Table 2. Fan-Pressurization Test Measurements on the Cottage at 50 Pa

	Leakage (cfm)
Room 1 (one window)	
No sealing (exhaust fan open)	83.7
Exhaust fan sealed	41.5
Exhaust fan and window sealed	36.8
Exhaust fan, window, and door sealed (outside)	33.7
Exhaust fan, window, and door sealed (inside)	25.1
Component leakage	
Exhaust Fan Duct	42.2
Window	4.7
Room 2 (two windows)	
Exhaust fan sealed	51.6
Exhaust fan and one window sealed	50.1
Exhaust fan and both windows sealed with polyethylene	49.4
Exhaust fan, both windows, and door sealed (outside)	45.5
Exhaust fan, both windows, and door sealed (inside)	40.4
Component leakage	
First Window	1.5
Second window	0.7

Measurements were taken on Room 2 on 21-22 Apr 97 and on Room 1 on 28 Apr 97.

7. PROCEDURES AND EQUIPMENT FOR SIMULANT (MS) CHALLENGES

7.1 Approach.

These experiments were designed to determine the effect of passive and active filtering, as measured by the ratio of dosages of agent/simulant inside and outside the cottage with varying tightness under three scenarios for sheltering: exiting/aerating the cottage immediately upon cloud passage (for maximum protection); delayed exiting/aerating; and operating a recirculation filter unit during and after exposure.

Cumulative air samples were taken inside the two closed rooms of the cottage during an hour-long challenge, and a second set of 4-hour samples was taken inside once the cottage was moved from the chamber into a clean area. The post-challenge samples were taken because in sheltering, the dosage continues to accrue inside after the hazardous cloud has passed, particularly if the doors and windows are not opened.

In each of the experiments with simulant, the cottage was exposed for an hour to a constant, uniform MS vapor concentration of about 5 mg/m^3 in the test chamber

of Bldg E5354 (a 40 ft by 20 ft by 14 ft high chamber). A transient vapor challenge was simulated by moving the cottage into the chamber before generating the challenge cloud and moving it out of the chamber immediately upon completion of the exposure. The air exchange rate of each room was varied slightly by applying expedient sealing techniques to one or both rooms.

7.2 Indoor Air Purifiers.

Experiments were run both with and without a consumer-type indoor air purifier in one of the two rooms. Six models of indoor air purifiers containing a carbon filter were purchased for evaluation from four manufacturers. These units, listed in Table 3, were evaluated for flow rate, capacity, and efficiency of removing semi-volatile organic compounds. The unit found to yield the best performance, the Honeywell Enviracare® model 13520, was used in the cottage in all experiments involving a filtration unit. This filter unit, which is shown in Figure 2, has a flow rate of 350 cfm through a carbon filter of 3¼ sq ft as well as a high efficiency particulate air (HEPA) filter. The cost of the filter unit was $188 retail, and a replacement filter element was $10. This unit was found to have the highest capacity of carbon filter among the six models evaluated.

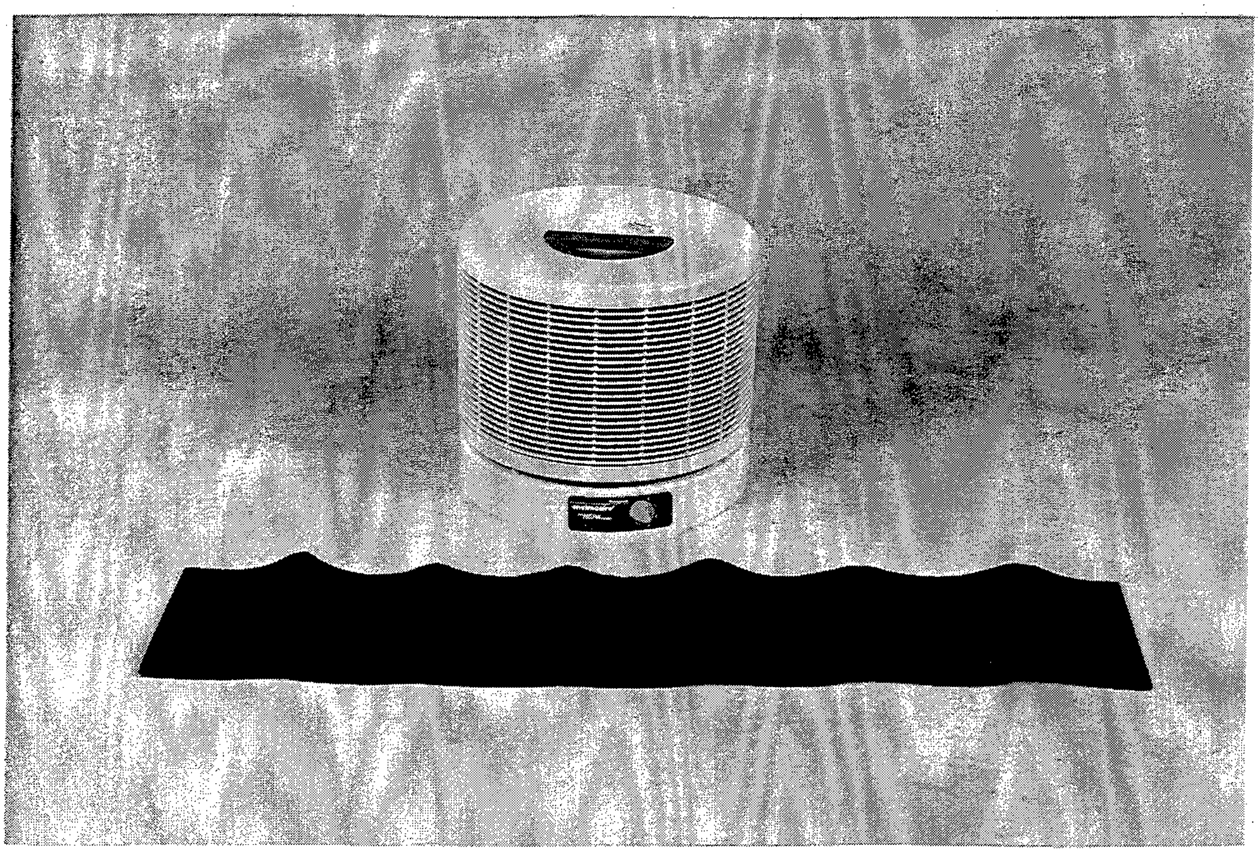

Figure 2. The Honeywell Enviracare® Filter Unit with its Carbon Filter in the Foreground.

Table 3. Consumer-type Recirculation Filters Evaluated

Manufacturer and Model Number	Unit Cost($)	Cost of Replacement Filters ($)	Cross-Sectional Filter Area (ft^2)	Filter Face Velocity (ft/min)	Flow Rate (ft^3/min)
Enviracare, 13520	188	10 pr	3.272	107	350
Hunter, 30100	100	25 ea	0.752	333	250
Hunter, 30050	80	25 ea	0.684	256	175
Holmes, HAP475	179	10 pr	0.458	371	170
Holmes, HAP240	70	20 ea	0.240	417	100
Bionaire, LC1060	100	15 pr	0.344	291	100

7.3 Air Sampling Equipment for Measuring MS Concentrations.

Two methods of air sampling--sorbent tubes and infrared analyzers--were employed in experiments with MS.

Sorbent tubes were used to measure average concentrations of MS sequentially over the three sampling periods: background, challenge, and post-challenge (after removing the cottage from the chamber). Three sorbent tubes were taken at each sample point for each sample period. The sampling flow was induced by a vacuum pump mounted on the outside of the cottage and connected by flexible tubing to an automatic sequencer with manifolds. The flow through each sorbent tube was regulated by use of nominal 1-ℓ/min critical orifices. This flow rate was measured before and after the test using a calibrated rotameter. Samples were also taken in the high-bay area adjacent to the exposure chamber to measure residual background concentrations around the cottage once it was removed from the chamber. The sorbent tubes were analyzed with a Perkin-Elmer Sigma 2000 gas chromatograph using a Flame Ionization Detector and Automatic Thermal Desorber (model ATD-50).

Miniature Infrared Analyzers (MIRAN®) manufactured by the Foxboro Co. were used for real-time concentration measurements. Two were positioned inside the cottage, one in each room, and one was placed outside the cottage to measure challenge concentrations in the chamber. Power was maintained continuously to each MIRAN® when the cottage was rolled out of the chamber. The MIRAN®, on different settings, was also used for measuring SF_6 concentrations to determine the natural air exchange rate of the cottage.

7.4 Procedures for Simulant Testing.

The cottage was kept outside the test chamber, in the high-bay area of Bldg E5354, at all times except during the challenge. This was to avoid exposing it to residual concentrations of MS existing in the test chamber. During this period the doors to the chamber were kept closed, and a negative pressure was maintained in the chamber to contain residual MS vapors. Overhead doors to the high-bay area were kept open to the outside for maximum ventilation during the post-exposure sampling period. A set of three

tubes was used to take air samples adjacent to the cottage to measure the background concentrations resulting from release of MS vapor from chamber during transition.

A clean filter element was installed in the recirculation filter unit for each experiment. The recirculation filter unit was turned on in the designated room as soon as interior background sampling began, and it was operated continuously throughout the challenge and the post-exposure periods.

Once background sampling was completed, the cottage was moved into the test chamber. MS vapor was then generated, presenting a challenge of 5 mg/m^3 that was maintained for 1 hour. Once the challenge period was complete, the vapor generator was turned off, the chamber purge fan was turned on, the large chamber doors were opened, and the cottage was moved out of the chamber. The doors to the chamber were then closed to contain residual vapors.

As soon as the cottage was out of the chamber and chamber doors were closed, air samplers in both rooms were remotely repositioned to the third set of sorbent tubes to measure the dosage inside during the residual phase for 4 hours. During this phase, the cottage doors were not opened, and the recirculation filter unit remained in operation. Air samples in the high-bay area were started to measure ambient backgrounds.

8. PROCEDURES AND EQUIPMENT FOR GB AND HD CHALLENGES

Procedures of the toxic agent experiments, conducted in Bldg E3566, were similar to those of the simulant experiments except that cottage was not moved out of the chamber after the challenge for safety reasons, and the air sampling rate and analytical procedures for sorbent tube samples differed. Post exposure sampling was conducted for a longer period and in three sequential segments of 4, 8, and 12 hours.

Each of the toxic agent experiments was conducted in the sealed toxic-agent test chamber with an external challenge concentration of 5 to 7 mg/m^3, for 1-hour duration (actual time varied from 60 to 75 minutes). The chamber, 32 feet in diameter and 20 feet high, was maintained at a negative 1.5 inches water gauge (iwg) pressure during challenges and a negative 0.25 iwg normally. A 5,000-cfm filter unit was used to purge the chamber after challenges. A small, low-flow mixing fan was used to stir the air in each room for uniformity of concentration. Large floor fans, not directed at the cottage, were used to stir the air in the chamber.

The natural air exchange rate of each room of the cottage was measured with SF_6 after the cottage was moved initially into the agent test chamber, immediately before the start of testing, to determine if changes in air exchange rate had resulted when the cottage was moved two miles to the toxic chamber.

The GB and HD challenges were conducted on the following dates in 1997.

GB-4 on 11-12 Sep	HD-1 on 13-14 Nov
GB-5 on 18-19 Sep	HD-2 on 18-19 Nov
GB-6 on 9-10 Oct	HD-3 on 20-21 Nov

8.1 Air Sampling for GB and HD Concentrations.

Three types of air sampling devices were employed in these experiments. Sorbent tubes analyzed by gas chromatograph and mass selective detector provided the primary air sample data in the cottage. Interior dosages were measured using sorbent tubes filled with the solid sorbent Tenax®. Air was drawn through each tube at a rate of 0.03 to 0.06 ℓ/minute, a rate much lower than that of the simulant testing because of constraints on the total quantity of agent per tube for laboratory analysis. The sorbent tubes were employed in sets of three to draw air from a single location in each room, the center of the room at a height of 3 feet. Thirty tubes were used for each experiment; three tubes were taken concurrently in each of the two rooms in each of five air sampling periods: background, challenge, and three post-challenge periods.

Background sampling measured the residual concentrations in the rooms for 30 minutes immediately before initiating the challenge. During the challenge period, dosages were measured inside the shelter by a second set of three sorbent tubes in both rooms of the cottage. Samples were drawn continuously for the challenge period. After the challenge, sorbent tube samples were taken in both rooms for 24 hours. This post-challenge sampling was divided into three sequential periods of increasing length: 4, 8, and 12 hours.

Sequencing of interior samples was controlled remotely as the cottage remained closed at all times during the challenge and post-challenge sampling periods. A Chrontrol® programmable timer and a mechanical sequencer activated by electrical pulses were used to control the sequencing. The vacuum source for the tubes was a Gast oil-less vacuum pump, one for each room. Unlike the experiments with MS, the vacuum pumps were positioned inside the cottage. A video camera was placed in each cottage to monitor the sequencers and ensure the switch was made in each of the sampling periods.

The quantity of agent on each sorbent tubes was measured by the Monitoring Branch Laboratory using a Hewlett-Packard 5890 Gas Chromatograph and 5970 Mass Selective Detector.

Four MIRAN® units were used in the test chamber to measure the challenge concentration. Two were also placed inside (one in each room); however, these proved to be affected by the increasing temperature in the rooms and their data was discarded. Concentrations in the chamber were measured by two MIRAN® for calculating protection factors. MIRAN® data were recorded automatically a Data Acquisition System.

A Minicams®, an automated gas chromatograph monitoring system manufactured by the CMS Research Corp, was used for post-test monitoring of chamber concentrations to determine when levels were low enough for the safe entry of chamber personnel wearing protective equipment.

8.2 Procedures for GB and HD Testing.

Once the sample tubes were mounted on the manifolds in each room, the airflow through each tube was measured and recorded. The sequencer was advanced

for these flow checks, and then returned to its starting position. Chrontrol timers were programmed, checked, and initiated. Agent was released as soon as the 30-minute background period was complete and the samplers were sequenced.

Doors and windows of the cottage remained closed throughout the 25-hour period of sampling for each trial. After the 24-hour post-challenge sampling, all sample tubes were removed from the cottage and capped.

Following completion of all toxic agent experiments, the cottage was removed from the chamber once air samples taken in the chamber and in the cottage showed concentrations to be below the 3-X level, which is 0.0001 mg/m^3 for GB and below 0.003 mg/m^3 for HD. Clearance sample for HD taken 33 days and 41 days after the last challenge test showed a concentration less than 0.00075 mg/m^3.

8.3 Analysis of Data.

Protection factors were calculated for each experiment as follows. Average concentration inside the cottage over the sample period was calculated by dividing the mass of simulant/agent on each sorbent tube (in μg) by the product of the sampling flow rate (in ℓ/minute) and sampling time (in minutes) to obtain a concentration in μg/ℓ or mg/m^3. The concentrations for the three co-located sample tubes were averaged, and from that value was subtracted the average background concentration measured in the cottage during a 30-minute sample period immediately before the challenge began. These background concentrations were a result of the previous experiment, but in some cases these residual concentrations were below the detection threshold for a 30-minute sample. The dosage for the sampling period (in mg-min/m^3) was calculated by multiplying the net average concentration by the duration of the challenge in minutes.

The challenge dosage was determined by averaging the concentrations measured by two MIRANs recording data at 20-second intervals and multiplying this average by the challenge period in minutes. The protection factor for the challenge period was calculated by dividing the challenge dosage by the dosage measured inside during the period. In calculating the protection factor for each of the 4-, 8-, and 12-hour post-challenge periods, the same challenge dosage was divided by the cumulative interior dosage measured to that point. Thus, to calculate the protection factor through 25 hours, the challenge dosage was divided by the sum of the four dosages measured inside: from 0 to 1 hour, from hours 1 through 5, from hours 5 through 13, and from hours 13 through 25. These data were tabulated and compared to values calculated using the equation for protection factor based on air exchange alone, which is shown in Section 4.1. In calculating the efficiency of filtering through hour 5, the interior dosage measured by sorbent tubes in the first two sample periods was divided by the 5-hour dosage calculated using the equation in Section 4.1, and the result was subtracted from 1.

9. RESULTS AND DISCUSSION

9.1 The Effect of Passive Filtering.

Tables 4 and 5 show the results of the experiments in terms of dosage and calculated efficiency of filtering--the reduction in interior dosage resulting from sorption of vapor by the cottage shell and interior surfaces. These results do not include the experiments in which a recirculation filter unit was operated in the room. The data are presented as 5-hour dosages accrued during and after a 1-hour exposure to a dosage in the range of 300 to 500 mg-min/m^3. They are compared to the 5-hour dosage values calculated for the same challenge with the air exchange rate measured by using the non-depositing tracer gas SF_6. Detailed air sample data are shown in Appendix B.

Table 4. Efficiency of Passive Filtering by Room 1 during and after 1-hr Challenge at 5-7 mg/m^3

Trial No.	Level of Expedient Sealing	Challenge dosage (mg-min/m^3)	5-hr dosage measured inside (mg-min/m^3)	Calculated 5-hr dosage based on air exchange rate*	Passive Filtering in 5 hr (%)
Methyl salicylate (MS)					
MS 12-1	None	334	25.3	69.6	63.6
MS 17-1	None	295	20.6	44.0	53.2
MS 19-1	Partial	326	18.5	66.5	72.2
MS 20-1	Partial	318	19.7	64.9	69.6
MS 9-1	Full	325	12.0	73.9	83.8
MS 11-1	Full	295	9.8	67.0	85.4
MS 14-1	Full	316	7.7	60.8	87.3
Sarin (GB)					
GB 4-1	Full	493	23.1	114.7	80.0
GB 5-1	Full	495	29.1	90.0	67.7
GB 6-1	Full	368	42.8	66.9	36.0
Mustard (HD)					
HD 1-1	Full	397	5.1	79.4	93.6
HD 2-1	Full	383	5.5	73.7	92.5
HD 3-1	Full	368	3.2	69.5	95.4

*During the MS series, tracer-gas dilution tests were performed on the cottage indoors on 24 May, 28 May, 21 June, 1 July, 9 July (twice), 22 July, and 23 July.

As shown in Tables 4 and 5, the efficiency of filtering--the percentage reduction in dosage--over the 5-hour period was very high for HD and its simulant MS. With HD, the efficiencies ranged from 92 to 95%, and with MS from 74 to 88% with MS with the cottage in its tightest configuration--with polyethylene sheeting over each window, the exhaust fan covered, and the door crack taped. Efficiencies were lower with GB, ranging from 36 to 79.9%.

The data show that filtering efficiency decreases as the air exchange rate increases. In the MS experiments, efficiencies in Room 1 were as low as 53% without sealing measures. The MS efficiencies were about 70% with partial sealing, and 74 to 88% with full sealing.

Table 5. Efficiency of Passive Filtering by Room 2 during and after 1-hr Challenge at 5-7 mg/m^3

Trial No.	Level of Expedient Sealing	Challenge dosage (mg-min/m^3)	5-hr dosage measured inside (mg-min/m^3)	Calculated 5-hr dosage based on air exchange rate*	Passive Filtering in 5 hr (%)
Methyl Salicylate (MS)					
MS 13-2	None	350	27.0	146	81.5
MS 16-2	None	314	24.7	131	81.1
MS 18-2	Partial	335	18.7	68.4	72.7
MS 20-2	Partial	318	18.1	64.9	72.1
MS 8-2	Full	345	14.3	65.1	78.0
MS 10-2	Full	370	11.0	69.8	84.2
MS 11-2	Full	295	14.4	55.7	74.1
MS 15-2	Full	332	7.8	67.8	88.5
Sarin (GB)					
GB 4-2	Full	493	74.7	205	63.6
GB 5-2	Full	495	70.6	183	61.4
GB 6-2	Full	368	86.0	136	36.8
Mustard (HD)					
HD 1-2	Full	397	8.0	153	94.8
HD 2-2	Full	383	8.3	147	94.4
HD 3-2	Full	368	6.1	142	95.7

*During the MS series, tracer-gas dilution tests were performed on the cottage indoors on 24 May, 28 May, 21 June, 1 July, 9 July (twice), 22 July, and 23 July.

The effect of filtering upon protection factor was substantial with both HD and GB, but it was much greater with HD, the less volatile of the two agents. As Table 6 shows, there was a very large difference between measured and calculated protection factors in each of the four sampling periods. With HD, the protection factors were at least 15 times greater, and as much as 50 times greater, than those predicted by air exchange alone.

Table 6. Protection Factors during and after a 1-hr Challenge with HD Vapor

Experiment	PF at 1 hr measured	PF at 1 hr calculated	PF at 5 hrs measured	PF at 5 hrs calculated	PF at 13 hrs measured	PF at 13 hrs calculated	PF at 25 hrs measured	PF at 25 hrs calculated
Room 1								
HD-1	1630	39.6	78.0	5.0	62.3	2.2	56.0	1.5
HD-2	658	36.8	82.3	5.2	59.9	2.3	54.2	1.5
HD-3	779	40.2	118	5.3	86.0	2.3	75.4	1.5
Room 2								
HD-1	260	17.7	49.8	2.6	36.1	1.4	32.5	1.1
HD-2	427	16.5	46.4	2.6	28.5	1.4	24.7	1.1
HD-3	291	18.0	62.0	2.6	39.1	1.4	35.0	1.1

Actual exposure times for the three experiments were 67 minutes, 72.3 minutes, and 66 minutes respectively. Challenge dosages were 397, 383, and 377 mg-min/m^3 for the three, respectively.

With GB, the effect of filtering was least during the challenge period, indicating a relatively low efficiency of removal as the vapor passed through the shell. In the final two trials, protection factors in this first sampling period were lower than the calculated value, indicating that the capacity for sorption may have been reduced by exposure in previous experiments and/or that uncontrolled variables, such as the interior-exterior temperature difference (as high as 25°F), were causing infiltration at a rate greater than was measured in the SF_6 test at the beginning of the toxic agent experiments.

With GB, the effect on protection factor was most evident in the latter sampling periods, where the measured protection factor was about 2 to 3 times the calculated protection factor. Thus, with GB as well as HD, it is apparent that one effect of filtering is to reduce the criticality of timing--how soon after cloud passage the occupants can exit or aerate the building.

Table 7. Protection Factors during and after a 1-hr Challenge with GB Vapor

Experiment	PF at 1 hr measured	PF at 1 hr calculated	PF at 5 hrs measured	PF at 5 hrs calculated	PF at 13 hrs measured	PF at 13 hrs calculated	PF at 25 hrs measured	PF at 25 hrs calculated
Room 1								
GB-4	57.3	35.1	15.2	4.3	9.5	2.1	7.2	1.4
GB-5	38.4	40.8	11.2	5.5	7.1	2.3	5.8	1.5
GB-6	54.1	40.8	8.6	5.5	5.1	2.3	3.9	1.5
Room 2								
GB-4	20.0	15.8	6.6	2.4	4.3	1.3	3.8	1.1
GB-5	18.8	18.3	7.0	2.7	4.5	1.4	3.9	1.1
GB-6	12.8	18.3	4.3	2.7	2.9	1.4	2.6	1.1

Exposure times for the three experiments were 75.8 min, 65 min, and 65 min respectively. Challenge dosages were 493, 495, and 368 mg-min/m^3 for the three, respectively.

Table 8 lists the concentrations measured in the cottage during and after the challenges with GB and HD. These too show a substantial difference between the two agents. Although the challenge concentrations were approximately the same in all trials, the resultant concentrations of HD in the cottage were about an order of magnitude lower than those with GB.

Table 8. Agent Concentrations in the Cottage Averaged over the Four Sample Periods during and after 5 mg/m^3 Challenges with GB and HD Vapor

Room 1 (one window)

Period	GB Challenges			HD Challenges		
	GB-4	GB-5	GB-6	HD-1	HD-2	HD-3
During challenge, hr 1	0.113	0.198	0.104	0.004	0.008	0.007
Post-challenge, hrs 2-5	0.100	0.131	0.150	0.020	0.016	0.011
Post-challenge, hrs 6-13	0.040	0.053	0.061	0.003	0.004	0.002
Post-challenge, hrs 14-25	0.023	0.022	0.030	0.001	0.001	0.001

Room 2 (two windows)

Period	GB Challenges			HD Challenges		
	GB-4	GB-5	GB-6	HD-1	HD-2	HD-3
During challenge, hr 1	0.325	0.405	0.442	0.023	0.012	0.020
Post-challenge, hrs 2-5	0.212	0.185	0.239	0.027	0.030	0.020
Post-challenge, hrs 6-13	0.084	0.081	0.090	0.006	0.011	0.007
Post-challenge, hrs 14-25	0.022	0.024	0.016	0.002	0.003	0.002

9.2 The Effect of a Recirculation Filter Unit.

Table 9 summarizes the results of 14 experiments with the 350-cfm Honeywell Enviracare® recirculation filter unit operating in one room of the cottage while it was challenged by MS vapor. These data show that substantially higher protection factors can be achieved with use of the recirculation filter unit.

With 1-hour dosage values (representing immediate exiting after cloud passage), protection factors in the room with the filter unit ranged from 104 to 860 with a mean value of 326. In comparison, without the filter unit, the protection factors ranged from 32 to 537 with a mean of 163. Thus, with MS, the recirculation filter unit doubled the protection factor based on a 1-hour exposure.

The effect was similar when 5-hour dosages were compared. With the recirculation filter, these ranged from 20 to 66 with a mean of 37. Without the filter unit, the range was 5 to 42 with a mean of 19.4.

The dependence upon air exchange rate is also apparent in the results shown in Table 9. As the air exchange rate of the room increases, the effect of the filter unit decreases.

Table 9. Dosages (mg-min/m^3) and Protection Factors with a 350-cfm Recirculation Filter Unit in the Room

Trial No.	Level of Expedient Sealing	1-hour Dosage Inside	5-hr Dosage Inside	Protection Factor With Immediate exiting (1-hr dosage value)	Protection Factor With delayed exiting (5-hr dosage value)
17-2	None	2.11	14.6	127	20
14-2	None	2.31	9.4	137	34
15-1	None	2.83	11.5	117	29
16-1	None	3.03	11.0	104	29
4-2	Partial	2.33	10.7	162	35
5-2	Partial	1.99	10.2	173	34
2-1	Partial	2.68	*	128	*
18-1	Partial	2.70	11.4	124	29
9-2	Full	0.38	6.6	860	49
8-1	Full	1.67	11.1	207	31
10-1	Full	0.58	7.7	637	45
12-2	Full	0.43	5.2	774	64
13-1	Full	0.72	7.9	488	44
19-2	Full	0.38	4.9	849	66

In these experiments, challenge dosages ranged from 295 to 382.

*In Trial No. 2-1, the dosage sample was taken for 8 hours after the challenge was completed. The 9-hr dosage measured in that trial was 8.4, and the protection factor over 9 hours was 45.2.

10. SUMMARY AND CONCLUSIONS

A series of controlled vapor challenges of a wooden cottage with chemical agents GB and HD and the mustard simulant MS have shown that sheltering in place can provide substantially higher protection factors than are predicted simply by air exchange.

In hour-long challenges with HD vapor, passive filtering--the sorption of agent by the building shell and interior surfaces--increased the protection provided by the cottage by a factor ranging from 15 to 50.

Improvements in protection were about an order of magnitude less with the more volatile GB. With this agent, protection factors calculated from post-exposure air samples were about two to three times higher than those predicted by air exchange alone.

Improvements due to filtering were greater when the air exchange rate of the cottage was reduced by expedient sealing measures, demonstrating that the rate at which the agent vapor is sorbed varies inversely with the air exchange rate of the building. The tighter the building, the greater is the efficiency of filtering.

Results of these experiments also indicate that filtering reduces the criticality of timing; that is, the protection does not diminish as rapidly with time as is predicted by air exchange alone.

When a consumer type indoor air purifier was operated in a room of the cottage--simulating its use in an expediently sealed safe room such as a bathroom--protection factors increased substantially. With a 350-cfm Honeywell Enviracare® unit, protection factors as high as 860 were measured with the mustard simulant MS (assuming immediate exiting, the sampling period equal to the challenge period) and as high as 66 for a 5-hour sampling period, representing a 4-hour delay in exiting.

Protection factors measured in these experiments are specific to the cottage tested and represent near-maximum values attainable, as convective forces due to wind were zero and inside-outside temperature differences were relatively small. Variations in materials, tightness of construction, ambient conditions, and duration of exposure can result in large variations in protection factor.

Further research is required to develop a predictive model for sheltering-versus-evacuation decisions. This work should include laboratory-scale experiments to measure sorption and desorption rates of agent vapors on a variety of building materials.

11. RECOMMENDATIONS

Further evaluate the practical application of selected indoor air purifiers in a designated safe room to increase the protection levels attainable in sheltering in place against the stockpile agents.

Revise protection factor estimates currently used for sheltering in place in CSEPP risk assessments to account for the effect of filtering, particularly with HD.

Conduct further research with each of the three stockpile agents to examine external and internal filtering on a laboratory scale with a range of construction materials.

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APPENDIX A
FAN PRESSURIZATION MEASUREMENTS MADE ON THE COTTAGE

50 Pa Leakage Rates of the Cottage in Various Configurations

Vent fan	Window 1	Window 2	Doo r	Date	Air Leakage (cfm)
ROOM 1					
Unsealed	Unsealed	--	Not taped	30 May	95.7
Unsealed	Unsealed	--	Not taped	6 June	92.7
Unsealed	Unsealed	--	Not taped	6 June	87.3
Unsealed	Unsealed	--	Not taped	28 June	74.3
Unsealed	Unsealed	--	Not taped	15 July	85.6
Sealed	Unsealed	--	Not taped	6 June	48.4
Sealed	Unsealed	--	Not taped	10 June	53.9
Sealed	Unsealed	--	Not taped	6 June	48.4
Sealed	Unsealed	--	Not taped	7 June	51.4
Sealed	Unsealed	--	Not taped	15 July	59.7
Sealed	Sealed	--	Not taped	10 June	49.9
Sealed	Sealed	--	Not taped	10 June	45.2
Sealed	Sealed	--	Not taped	6 June	45.2
Sealed	Sealed	--	Taped outside	10 June	45.2
Sealed	Sealed	--	Taped outside	15 July	45.2
Sealed	Unsealed	--	Taped outside	7 June	43.8
Sealed	Unsealed	--	Taped inside	11 June	49.9
Sealed	Sealed	--	Taped inside	11 June	48.4
Sealed	Sealed	--	Taped inside	15 July	41.7
Without baseboard molding, outlet covers, or floor covering*				13 May	181.4
ROOM 2					
Unsealed	Unsealed	Unsealed	Not taped	3 June	106.4
Unsealed	Unsealed	Unsealed	Not taped	15 July	113.1
Unsealed	Unsealed	Unsealed	Not taped	5 June	109.4
Sealed	Unsealed	Unsealed	Not taped	4 June	76.8
Sealed	Unsealed	Unsealed	Not taped	15 July	71.9
Sealed	Sealed	Unsealed	Not taped	4 June	69.5
Sealed	Sealed	Unsealed	Not taped	3 June	63.0
Sealed	Sealed	Unsealed	Not taped	5 June	70.0
Sealed	Sealed	Unsealed	Not taped	5 June	65.0
Sealed	Sealed	Sealed	Not taped	4 June	60.0
Sealed	Sealed	Unsealed	Taped outside	5 June	67.6
Sealed	Sealed	Unsealed	Taped inside	21 June	45.2
Sealed	Sealed	Sealed	Taped inside	5 June	43.5
Sealed	Sealed	Sealed	Taped outside	21 June	45.2
Without baseboard molding, outlet covers, or floor covering*				13 May	203.2

* Unfinished condition

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APPENDIX B
AIR SAMPLING DATA

Trial MS-2 Methyl Salicylate Vapor Challenge Date: 17 May 96

Location: Room 1 (Partially sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	163	0.83	14:00	14:30	30	0.105	0.0042	0.0046
Bkground-2	164	0.87	14:00	14:30	30	0.116	0.0044	(0.0004)
Bkground-3	165	0.74	14:00	14:30	30	0.113	0.0051	
Dose-1	166	0.8	14:40	15:40	60	1.869	0.0389	0.0492
Dose-2	167	0.8	14:40	15:40	60	2.652	0.0552	(0.0073)
Dose-3	168	0.8	14:40	15:40	60	2.569	0.0535	
8-hr post-1	169	0.9	15:57	23:57	480	5.066	0.0117	0.0120
8-hr post-2	170	0.9	15:57	23:57	480	5.279	0.0122	(0.0002)
8-hr post-3	172	0.9	15:57	23:57	480	5.226	0.0121	
				Net Chal Level Conc:			0.0447	
				8-hr post Conc:			0.0120	

Location: Room 2 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	173	0.9	14:00	14:30	30	0.270	0.0100	0.0088
Bkground-2	176	0.89	14:00	14:30	30	0.238	0.0089	(0.0011)
Bkground-3	179	0.9	14:00	14:30	30	0.200	0.0074	
Dose-1	180	0.93	14:40	15:40	60	7.413	0.1329	0.1346
Dose-2	181	0.9	14:40	15:40	60	7.190	0.1331	(0.0023)
Dose-3	186	0.9	14:40	15:40	60	7.441	0.1378	
8-hr post-1	187	0.92	15:57	23:57	480	0.000	lost	0.0275
8-hr post-2	188	0.88	15:57	23:57	480	0.000	data	
8-hr post-3	189	0.92	15:57	23:57	480	12.143	0.0275	
				Net Chal Level Conc:			0.1258	
				8-hr post Conc:			0.0275	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	196	0.74	15:57	23:57	480	3.135	0.0088	0.0091
Bkground-2	204	0.92	15:57	23:57	480	4.134	0.0094	(0.0002)
Bkground-3	205	0.93	15:57	23:57	480	4.066	0.0091	

Avg Chal Conc: 5.767
Chal Dosage: 382.0

	Room 1	Room 2
Bkground Temp (°F)	76.9	76.8
Challenge Temp (°F)	79.2	76.5
4-hr post Temp (°F)	80.6	75.5

Trial MS-3 Methy Salicylate Vapor Challenge Date: 20 May 96

Location: Room 1 with Recirculation Filter

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	206	0.9	13:50	14:20	30	0.523	0.0194	0.0151
Bkground-2	208	0.9	13:50	14:20	30	0.335	0.0124	(0.0030)
Bkground-3	209	0.9	13:50	14:20	30	0.368	0.0136	
Dose-1	215	0.9	14:30	15:30	60	4.325	0.0801	0.0808
Dose-2	217	0.85	14:30	15:30	60	4.115	0.0807	(0.0007)
Dose-3	219	0.85	14:30	15:30	60	4.167	0.0817	
4-hr post-1	220	0.95	15:55	19:55	240	56.448	0.2476	0.2431
4-hr post-2	226	1	15:55	19:55	240	56.474	0.2353	(0.0055)
4-hr post-3	227	0.95	15:55	19:55	240	56.191	0.2465	
				Net Chal Level Conc:			0.0657	
				4-hr post Conc:			0.2431	

Location: Room 2 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	235	0.95	13:50	14:20	30	1.017	0.0357	0.0313
Bkground-2	237	0.95	13:50	14:20	30	1.031	0.0362	(0.0065)
Bkground-3	243	0.95	13:50	14:20	30	0.630	0.0221	
Dose-1	247	0.97	14:30	15:30	60	14.827	0.2548	0.2575
Dose-2	255	0.95	14:30	15:30	60	14.820	0.2600	(0.0021)
Dose-3	258	0.93	14:30	15:30	60	14.383	0.2578	
4-hr post-1	261	1	15:55	19:55	240	59.480	0.2478	0.2551
4-hr post-2	262	0.95	15:55	19:55	240	59.000	0.2588	(0.0052)
4-hr post-3	263	0.95	15:55	19:55	240	59.000	0.2588	
				Net Chal Level Conc:			0.2262	
				4-hr post Conc:			0.2551	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	264	0.95	15:55	19:55	240	5.985	0.0262	0.0319
Bkground-2	265	1	15:55	19:55	240	8.855	0.0369	(0.0044)
Bkground-3	268	1	15:55	19:55	240	7.817	0.0326	

Avg Chal Conc: 4.955
Chal Dosage: 377.5

	Room 1	Room 2
Bkground Temp (°F)	76.9	76.8
Challenge Temp (°F)	79.2	76.5
4-hr post Temp (°F)	80.6	75.5

Trial MS-4 Methyl Salicylate Vapor Challenge Date: 21 May 96

Location: Room 1 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	292	0.95	13:30	14:00	30	0.639	0.0224	0.0230
Bkground-2	293	0.95	13:30	14:00	30	0.676	0.0237	(0.0005)
Bkground-3	295	0.95	13:30	14:00	30	0.649	0.0228	
Dose-1	296	0.95	14:05	15:05	60	15.402	0.2702	0.2789
Dose-2	299	0.95	14:05	15:05	60	15.972	0.2802	(0.0066)
Dose-3	311	0.9	14:05	15:05	60	15.457	0.2862	
4-hr post-1	326	0.95	15:30	19:30	240	24.055	0.1055	0.1065
4-hr post-2	334	0.95	15:30	19:30	240	24.745	0.1085	(0.0014)
4-hr post-3	337	0.95	15:30	19:30	240	24.079	0.1056	
				Net Chal Level Conc:			0.2559	
				4-hr post Conc:			0.1065	

Location: Room 2 (Partially sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	269	0.9	13:30	14:00	30	0.536	0.0199	0.0196
Bkground-2	270	0.95	13:30	14:00	30	0.530	0.0186	(0.0007)
Bkground-3	271	0.9	13:30	14:00	30	0.547	0.0202	
Dose-1	272	0.9	14:05	15:05	60	2.941	0.0545	0.0585
Dose-2	273	0.85	14:05	15:05	60	3.131	0.0614	(0.0029)
Dose-3	279	0.85	14:05	15:05	60	3.040	0.0596	
4-hr post-1	285	0.95	15:30	19:30	240	8.039	0.0353	0.0348
4-hr post-2	290	0.95	15:30	19:30	240	8.450	0.0371	(0.0021)
4-hr post-3	291	0.95	15:30	19:30	240	7.312	0.0321	
				Net Chal Level Conc:			0.0389	
				4-hr post Conc:			0.0348	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	342	0.9	15:30	19:30	240	6.105	0.0283	0.0349
Bkground-2	383	0.95	15:30	19:30	240	9.032	0.0396	(0.0048)
Bkground-3	389	0.9	15:30	19:30	240	7.973	0.0369	

Avg Chal Conc: 4.955
Chal Dosage: 377.5

	Room 1	Room 2
Bkground Temp (°F)	89.5	88.5
Challenge Temp (°F)	92.4	89.4
4-hr post Temp (°F)	95.7	89.4

Trial MS-5 Methyl Salicylate Vapor Challenge Date: 22 May 96

Location: Room 1 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	313	0.93	14:00	14:30	30	0.445	0.0159	0.0235
Bkground-2	317	0.93	14:00	14:30	30	0.421	0.0151	(0.0113)
Bkground-3	341	0.97	14:00	14:30	30	1.148	0.0394	
Dose-1	351	0.8	14:40	15:40	60	7.853	0.1636	0.1532
Dose-2	362	0.9	14:40	15:40	60	8.056	0.1492	(0.0075)
Dose-3	363	0.9	14:40	15:40	60	7.922	0.1467	
4-hr post-1	380	0.87	16:10	17:10	60	5.061	0.0969	0.0752
4-hr post-2	384	0.93	17:10	18:10	60	4.270	0.0765	(0.0138)
4-hr post-3	388	0.9	18:10	19:10	60	3.612	0.0669	
4-hr post-4	400	0.8	19:10	20:10	60	2.894	0.0603	
				Net Chal Level Conc:			0.1297	
				4-hr post Conc:			0.0752	

Location: Room 2 (Partially sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	300	0.87	14:00	14:30	30	0.703	0.0269	0.0213
Bkground-2	301	0.87	14:00	14:30	30	0.483	0.0185	(0.0040)
Bkground-3	302	0.87	14:00	14:30	30	0.482	0.0185	
Dose-1	303	0.87	14:40	15:40	60	3.290	0.0630	0.0544
Dose-2	304	0.87	14:40	15:40	60	2.566	0.0492	(0.0062)
Dose-3	305	0.87	14:40	15:40	60	2.658	0.0509	
4-hr post-1	306	0.97	16:10	17:10	60	3.612	0.0621	0.0419
4-hr post-2	307	0.97	17:10	18:10	60	2.106	0.0362	(0.0117)
4-hr post-3	308	0.97	18:10	19:10	60	2.055	0.0353	
4-hr post-4	310	1	19:10	20:10	60	2.033	0.0339	
				Net Chal Level Conc:			0.0331	
				4-hr post Conc:			0.0419	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	343	0.93	16:10	20:10	240	1.651	0.0074	0.0076
Bkground-2	385	0.9	16:10	20:10	240	1.561	0.0072	(0.0004)
Bkground-3	390	0.87	16:10	20:10	240	1.698	0.0081	

Avg Chal Conc: 5.049
Chal Dosage: 343.3

	Room 1	Room 2
Bkground Temp (°F)	80.4	82.3
Challenge Temp (°F)	81.9	86.0
4-hr post Temp (°F)	82.5	88.8

Trial MS-7 **Methyl Salicylate Vapor Challenge** **Date: 5 June 96**

Location: Room 1 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	156	0.87	13:20	13:50	30	0.533	0.0204	0.0177
Bkground-2	161	0.9	13:20	13:50	30	0.430	0.0159	(0.0020)
Bkground-3	173	0.9	13:20	13:50	30	0.449	0.0166	
Dose-1	174	0.87	13:55	14:55	60	6.868	0.1316	0.1495
Dose-2	176	0.88	13:55	14:55	60	7.897	0.1496	(0.0146)
Dose-3	187	0.87	13:55	14:55	60	8.739	0.1674	
4-hr post-1	188	0.95	15:05	16:05	60	10.220	0.1793	0.1583
4-hr post-2	189	0.97	16:05	17:05	60	9.529	0.1637	(0.0144)
4-hr post-3	215	0.97	17:05	18:05	60	8.576	0.1474	
4-hr post-4	489	0.9	18:05	19:05	60	7.718	0.1429	
				Net Chal Level Conc:			0.1319	
				4-hr post Conc:			0.1583	

Location: Room 2 (Partially sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	219	0.87	13:20	13:50	30	0.400	0.0153	0.0171
Bkground-2	220	0.88	13:20	13:50	30	0.540	0.0204	(0.0023)
Bkground-3	255	0.88	13:20	13:50	30	0.414	0.0157	
Dose-1	265	0.95	13:55	14:55	60	9.750	0.1710	0.1757
Dose-2	342	0.97	13:55	14:55	60	9.891	0.1700	(0.0073)
Dose-3	420	0.91	13:55	14:55	60	10.153	0.1860	
4-hr post-1	437	0.87	15:05	16:05	60	13.304	0.2549	0.2250
4-hr post-2	438	0.93	16:05	17:05	60	12.907	0.2313	(0.0227)
4-hr post-3	440	0.87	17:05	18:05	60	11.616	0.2225	
4-hr post-4	485	0.91	18:05	19:05	60	10.454	0.1915	
				Net Chal Level Conc:			0.1585	
				4-hr post Conc:			0.2250	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	12	1	15:25	19:43	258	9.416	0.0365	0.0485
Bkground-2	17	0.6	15:25	19:43	258	8.686	0.0561	(0.0086)
Bkground-3	27	0.97	15:25	19:43	258	13.202	0.0528	

Avg Chal Conc:	4.567
Chal Dosage:	310.5

	Room 1	Room 2
Bkground Temp (°F)	77.3	77.4
Challenge Temp (°F)	77.1	78.2
4-hr post Temp (°F)	78.9	82.5

Trial MS-8 Methyl Salicylate Vapor Challenge Date: 18 June 96

Location: Room 1 (Fully sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	342	0.87	13:30	14:00	30	0.590	0.0226	0.0254
Bkground-2	383	0.85	13:30	14:00	30	0.657	0.0257	(0.0022)
Bkground-3	387	0.78	13:30	14:00	30	0.655	0.0280	
Dose-1	389	0.77	14:10	15:10	60	2.388	0.0517	0.0532
Dose-2	400	0.72	14:10	15:10	60	2.319	0.0537	(0.0011)
Dose-3	420	0.83	14:10	15:10	60	2.704	0.0543	
4-hr post-1	320	0.96	15:30	16:30	60	2.779	0.0482	0.0391
4-hr post-2	321	0.98	16:30	17:30	60	2.332	0.0397	(0.0059)
4-hr post-3	323	0.97	17:30	18:30	60	2.080	0.0357	
4-hr post-4	324	0.97	18:30	19:30	60	1.897	0.0326	
				Net Chal Level Conc:			0.0278	
				4-hr post Conc:			0.0391	

Location: Room 2 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	437	0.87	13:30	14:00	30	0.899	0.0344	0.0350
Bkground-2	438	0.87	13:30	14:00	30	0.921	0.0353	(0.0004)
Bkground-3	440	0.87	13:30	14:00	30	0.919	0.0352	
Dose-1	443	0.86	14:10	15:10	60	2.639	0.0511	0.0512
Dose-2	480	0.86	14:10	15:10	60	2.634	0.0510	(0.0001)
Dose-3	483	0.87	14:10	15:10	60	2.682	0.0514	
4-hr post-1	359	0.8	15:30	16:30	60	2.809	0.0585	0.0557
4-hr post-2	361	0.87	16:30	17:30	60	2.853	0.0546	(0.0017)
4-hr post-3	385	0.87	17:30	18:30	60	2.818	0.0540	
4-hr post-4	386	0.85	18:30	19:30	60	2.836	0.0556	
				Net Chal Level Conc:			0.0162	
				4-hr post Conc:			0.0557	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	219	0.57	15:30	19:30	240	7.699	0.0563	0.0415
Bkground-2	220	0.97	15:30	19:30	240	8.060	0.0346	(0.0105)
Bkground-3	265	0.98	15:30	19:30	240	7.869	0.0335	

Avg Chal Conc: 5.151
Chal Dosage: 345.1

	Room 1	Room 2	Outer
Bkground Temp (°F)	83.6	80.0	80.6
Challenge Temp (°F)	87.2	81.8	84.0
4-hr post Temp (°F)	92.4	83.3	83.1

Trial MS-9 Methyl Salicylate Vapor Challenge Date: 19 June 96

Location: Room 1 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	301	0.87	13:30	14:00	30	0.417	0.0160	0.0167
Bkground-2	303	0.9	13:30	14:00	30	0.465	0.0172	(0.0005)
Bkground-3	304	0.89	13:30	14:00	30	0.453	0.0170	
Dose-1	305	0.88	14:10	15:10	60	1.843	0.0349	0.0365
Dose-2	307	0.9	14:10	15:10	60	1.989	0.0368	(0.0011)
Dose-3	308	0.89	14:10	15:10	60	2.010	0.0376	
4-hr post-1	310	0.98	15:30	16:30	60	2.781	0.0473	0.0450
4-hr post-2	311	0.97	16:30	17:30	60	2.702	0.0464	(0.0019)
4-hr post-3	313	0.96	17:30	18:30	60	2.488	0.0432	
4-hr post-4	317	0.97	18:30	19:30	60	2.505	0.0430	
				Net Chal Level Conc:			0.0197	
				4-hr post Conc:			0.0450	

Location: Room 2 (Fully sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	322	0.97	13:30	14:00	30	0.684	0.0235	0.0229
Bkground-2	326	0.93	13:30	14:00	30	0.621	0.0223	(0.0005)
Bkground-3	337	0.94	13:30	14:00	30	0.648	0.0230	
Dose-1	338	0.92	14:10	15:10	60	1.679	0.0304	0.0292
Dose-2	340	0.91	14:10	15:10	60	1.562	0.0286	(0.0009)
Dose 3	341	0.91	14:10	15:10	60	1.559	0.0286	
4-hr post-1	351	0.78	15:30	16:30	60	1.450	0.0310	0.0261
4-hr post-2	362	0.86	16:30	17:30	60	1.413	0.0274	(0.0033)
4-hr post-3	363	0.89	17:30	18:30	60	1.250	0.0234	
4-hr post-4	380	0.83	18:30	19:30	60	1.132	0.0227	
				Net Chal Level Conc:			0.0063	
				4-hr post Conc:			0.0261	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	204	0.97	15:30	19:30	240	7.699	0.0331	0.0338
Bkground-2	293	0.97	15:30	19:30	240	8.060	0.0346	(0.0006)
Bkground-3	298	0.97	15:30	19:30	240	7.869	0.0338	

Avg Chal Conc: 5.081
Chal Dosage: 325.2

	Room 1	Room 2	Outer
Bkground Temp (°F)	80.7	81.1	75.9
Challenge Temp (°F)	82.1	84.9	80.2
4-hr post Temp (°F)	83.0	88.0	79.1

Trial MS-10 Methyl Salicylate Vapor Challenge Date: 20 June 96

Location: Room 1 (Fully sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	103	0.9	13:30	14:00	30	0.710	0.0263	0.0257
Bkground-2	105	0.9	13:30	14:00	30	0.685	0.0254	(0.0004)
Bkground-3	107	0.9	13:30	14:00	30	0.686	0.0254	
Dose-1	122	0.87	14:10	15:10	60	1.910	0.0366	0.0354
Dose-2	139	0.9	14:10	15:10	60	1.801	0.0333	(0.0015)
Dose-3	140	0.87	14:10	15:10	60	1.891	0.0362	
4-hr post-1	149	0.95	15:30	16:30	60	2.161	0.0379	0.0322
4-hr post-2	157	0.95	16:30	17:30	60	1.950	0.0342	(0.0041)
4-hr post-3	163	0.97	17:30	18:30	60	1.638	0.0281	
4-hr post-4	165	0.85	18:30	19:30	60	1.456	0.0285	
				Net Chal Level Conc:			0.0097	
				4-hr post Conc:			0.0322	

Location: Room 2 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	166	0.73	13:30	14:00	30	0.481	0.0220	0.0224
Bkground-2	167	0.8	13:30	14:00	30	0.527	0.0219	(0.0007)
Bkground-3	168	0.85	13:30	14:00	30	0.597	0.0234	
Dose-1	169	0.93	14:10	15:10	60	2.869	0.0514	0.0519
Dose-2	170	0.9	14:10	15:10	60	2.874	0.0532	(0.0009)
Dose-3	172	0.93	14:10	15:10	60	2.855	0.0512	
4-hr post-1	176	0.95	15:30	16:30	60	2.200	0.0386	0.0383
4-hr post-2	179	0.9	16:30	17:30	60	2.109	0.0390	(0.0006)
4-hr post-3	180	0.95	17:30	18:30	60	2.166	0.0380	
4-hr post-4	181	0.95	18:30	19:30	60	2.131	0.0374	
				Net Chal Level Conc:			0.0295	
				4-hr post Conc:			0.0383	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	209	1	15:30	19:30	240	2.325	0.0097	0.0107
Bkground-2	237	0.9	15:30	19:30	240	2.648	0.0123	(0.0011)
Bkground-3	252	0.9	15:30	19:30	240	2.171	0.0101	

Avg Chal Conc: 5.012
Chal Dosage: 370.9

	Room 1	Room 2	Outer
Bkground Temp (°F)	86.6	81.0	80.7
Challenge Temp (°F)	87.3	82.9	83.1
4-hr post Temp (°F)	92.0	83.5	79.1

Trial MS-11 Methyl Salicylate Vapor Challenge Date: 25 June 96

Location: Room 1 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	205	0.88	13:12	13:42	30	0.494	0.0187	0.0170
Bkground-2	206	0.91	13:12	13:42	30	0.441	0.0162	(0.0012)
Bkground-3	226	0.88	13:12	13:42	30	0.422	0.0160	
Dose-1	240	0.84	15:15	16:15	60	1.705	0.0338	0.0418
Dose-2	243	0.87	15:15	16:15	60	1.664	0.0319	(0.0127)
Dose-3	258	0.87	15:15	16:15	60	3.118	0.0597	
4-hr post-1	261	0.96	16:30	17:30	60	2.413	0.0419	0.0346
4-hr post-2	262	0.98	17:30	18:30	60	2.221	0.0189	(0.0091)
4-hr post-3	263	0.97	18:30	19:30	60	2.263	0.0389	
4-hr post-4	269	0.98	19:30	20:30	60	2.268	0.0386	
				Net Chal Level Conc:			0.0249	
				4-hr post Conc:			0.0346	

Location: Room 2 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	302	0.82	13:12	13:42	30	0.637	0.0259	0.0244
Bkground-2	306	0.82	13:12	13:42	30	0.598	0.0243	(0.0011)
Bkground-3	318	0.82	13:12	13:42	30	0.568	0.0231	
Dose-1	319	0.89	15:15	16:15	60	2.649	0.0496	0.0492
Dose-2	327	0.9	15:15	16:15	60	2.701	0.0500	(0.0009)
Dose-3	336	0.85	15:15	16:15	60	2.442	0.0479	
4-hr post-1	344	0.91	16:30	17:30	60	3.577	0.0655	0.0540
4-hr post-2	345	0.9	17:30	18:30	120	3.221	0.0298	(0.0142)
4-hr post-3	347	0.93	18:30	19:30	60	3.502	0.0628	
4-hr post-4	356	0.9	19:30	20:30	60	3.120	0.0578	
				Net Chal Level Conc:			0.0247	
				4-hr post Conc:			0.0540	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	209	1	16:30	20:30	240	4.245	0.0177	0.0177
Bkground-2	237	0.9	16:30	20:30	240	4.169	0.0193	(0.0013)
Bkground-3	252	0.9	16:30	20:30	240	3.503	0.0162	

Avg Chal Conc: 4.619
Chal Dosage: 295.6

	Room 1	Room 2	Outer
Bkground Temp (°F)	88.5	87.9	84.9
Challenge Temp (°F)	89.4	88.4	86.2
4-hr post Temp (°F)	91.0	88.9	85.9

Trial MS-12 Methyl Salicylate Vapor Challenge **Date: 26 June 96**

Location: Room 1 (No sealing - without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	255	0.87	13:45	14:15	30	0.348	0.0133	0.0152
Bkground-2	264	0.91	13:45	14:15	30	0.443	0.0162	(0.0013)
Bkground-3	268	0.84	13:45	14:15	30	0.405	0.0161	
Dose-1	270	0.87	14:45	15:45	60	4.875	0.0934	0.0918
Dose-2	271	0.9	14:45	15:45	60	4.864	0.0901	(0.0014)
Dose-3	272	0.89	14:45	15:45	60	4.904	0.0918	
4-hr post-1	273	0.96	16:00	17:00	60	5.740	0.0997	0.0865
4-hr post-2	279	0.97	17:00	18:00	60	5.150	0.0885	(0.0088)
4-hr post-3	281	0.95	18:00	19:00	60	4.682	0.0821	
4-hr post-4	284	0.98	19:00	20:00	60	4.456	0.0758	
				Net Chal Level Conc:			0.0766	
				4-hr post Conc:			0.0865	

Location: Room 2 (Fully sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc Std Dev mg/m^3
Bkground-1	285	0.88	13:45	14:15	30	0.444	0.0168	0.0146
Bkground-2	288	0.87	13:45	14:15	30	0.356	0.0136	(0.0015)
Bkground-3	290	0.91	13:45	14:15	30	0.367	0.0134	
Dose-1	291	0.9	14:45	15:45	60	1.127	0.0209	0.0218
Dose-2	292	0.9	14:45	15:45	60	1.241	0.0230	(0.0009)
Dose-3	295	0.88	14:45	15:45	60	1.138	0.0216	
4-hr post-1	296	0.93	16:00	17:00	60	1.313	0.0235	0.0200
4-hr post-2	297	0.93	17:00	18:00	60	1.055	0.0189	(0.0020)
4-hr post-3	299	0.94	18:00	19:00	60	1.066	0.0189	
4-hr post-4	300	0.93	19:00	20:00	60	1.051	0.0188	
				Net Chal Level Conc:			0.0072	
				4-hr post Conc:			0.0200	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	209	1	16:00	20:00	240	3.390	0.0141	0.0146
Bkground-2	237	0.9	16:00	20:00	240	3.567	0.0165	(0.0014)
Bkground-3	252	0.9	16:00	20:00	240	2.842	0.0132	

Avg Chal Conc: 4.845
Chal Dosage: 334.3

	Room 1	Room 2	Outer
Bkground Temp (°F)	82.7	83.2	82.8
Challenge Temp (°F)	82.8	88.0	83.7
4-hr post Temp (°F)	85.6	92.5	85.3

Trial MS-13 Methyl Salicylate Vapor Challenge Date: 3 July 96

Location: Room 1 (Fully sealed with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	219	0.84	14:10	14:40	30	0.454	0.0180	0.0178
Bkground-2	265	0.9	14:10	14:40	30	0.484	0.0179	(0.0002)
Bkground-3	309	0.87	14:10	14:40	30	0.458	0.0175	
Dose-1	314	0.85	15:05	16:05	60	1.554	0.0305	0.0298
Dose-2	315	0.87	15:05	16:05	60	1.492	0.0286	(0.0009)
Dose-3	316	0.87	15:05	16:05	60	1.582	0.0303	
4-hr post-1	320	0.93	16:20	17:20	60	2.567	0.0460	0.0299
4-hr post-2	321	0.97	17:20	18:20	60	1.717	0.0295	(0.0098)
4-hr post-3	323	0.97	18:20	19:20	60	1.334	0.0229	
4-hr post-4	324	0.97	19:20	20:20	60	1.224	0.0210	
				Net Chal Level Conc:			0.0120	
				4-hr post Conc:			0.0299	

Location: Room 2 (No sealing - without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	342	0.97	14:10	14:40	30	0.480	0.0165	0.0164
Bkground-2	359	0.8	14:10	14:40	30	0.412	0.0172	(0.0007)
Bkground-3	361	0.9	14:10	14:40	30	0.419	0.0155	
Dose-1	383	0.9	15:05	16:05	60	5.031	0.0932	0.0936
Dose-2	385	0.88	15:05	16:05	60	4.882	0.0925	(0.0012)
Dose-3	386	0.87	15:05	16:05	60	4.972	0.0952	
4-hr post-1	387	0.81	16:20	17:20	60	5.417	0.1115	0.0934
4-hr post-2	389	0.82	17:20	18:20	60	4.669	0.0949	(0.0119)
4-hr post-3	400	0.77	18:20	19:20	60	4.093	0.0886	
4-hr post-4	420	0.86	19:20	20:20	60	4.063	0.0787	
				Net Chal Level Conc:			0.0772	
				4-hr post Conc:			0.0934	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	239	0.93	16:20	20:20	240	3.901	0.0175	0.0172
Bkground-2	244	0.9	16:20	20:20	240	3.683	0.0171	(0.0002)
Bkground-3	247	0.9	16:20	20:20	240	3.664	0.0170	

			Room 1	Room 2	Outer
Avg Chal Conc:	5.073				
Chal Dosage:	350.03	Bkground Temp (°F)	83.3	81.2	81.0
		Challenge Temp (°F)	87.0	82.8	81.3
		4-hr post Temp (°F)	91.5	84.0	80.1

Trial MS-14 Methyl Salicylate Vapor Challenge Date: 5 July 96

Location: Room 1 (Fully sealed without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	304	0.87	11:50	12:20	30	0.216	0.0083	0.0081
Bkground-2	305	0.92	11:50	12:20	30	0.200	0.0072	(0.0006)
Bkground-3	307	0.9	11:50	12:20	30	0.234	0.0087	
Dose-1	310	0.87	12:45	13:45	60	1.178	0.0226	0.0220
Dose-2	311	0.87	12:45	13:45	60	1.139	0.0218	(0.0004)
Dose-3	313	0.87	12:45	13:45	60	1.136	0.0218	
4-hr post-1	317	0.95	14:00	15:00	60	1.935	0.0339	0.0285
4-hr post-2	322	0.98	15:00	16:00	60	1.594	0.0271	(0.0031)
4-hr post-3	326	0.97	16:00	17:00	60	1.552	0.0267	
4-hr post-4	333	0.97	17:00	18:00	60	1.538	0.0264	
				Net Chal Level Conc:			0.0140	
				4-hr post Conc:			0.0285	

Location: Room 2 (No sealing - with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	337	0.97	11:50	12:20	30	0.364	0.0125	0.0119
Bkground-2	338	0.97	11:50	12:20	30	0.346	0.0119	(0.0005)
Bkground-3	340	0.97	11:50	12:20	30	0.332	0.0114	
Dose-1	341	0.97	12:45	13:45	60	2.744	0.0471	0.0505
Dose-2	343	0.97	12:45	13:45	60	2.799	0.0481	(0.0041)
Dose-3	351	0.78	12:45	13:45	60	2.629	0.0562	
4-hr post-1	357	0.87	14:00	15:00	60	2.349	0.0450	0.0329
4-hr post-2	362	0.87	15:00	16:00	60	1.670	0.0320	(0.0072)
4-hr post-3	363	0.87	16:00	17:00	60	1.432	0.0274	
4-hr post-4	380	0.83	17:00	18:00	60	1.359	0.0273	
				Net Chal Level Conc:			0.0385	
				4-hr post Conc:			0.0329	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	144	0.97	14:00	18:00	240	3.636	0.0156	0.0135
Bkground-2	145	0.97	14:00	18:00	240	3.657	0.0157	(0.0030)
Bkground-3	146	0.97	14:00	18:00	240	2.150	0.0092	

			Room 1	Room 2	Outer
Avg Chal Conc:	4.608				
Chal Dosage:	316.85	Bkground Temp (°F)	79.3	82.7	79.1
		Challenge Temp (°F)	80.8	84.3	79.7
		4-hr post Temp (°F)	83.2	90.2	85.3

Trial MS-15 Methyl Salicylate Vapor Challenge Date: 8 July 96

Location: Room 1 (No sealing measures, with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	102	0.83	13:35	14:05	30	0.203	0.0082	0.0091
Bkground-2	106	0.86	13:35	14:05	30	0.253	0.0098	(0.0007)
Bkground-3	109	0.87	13:35	14:05	30	0.244	0.0093	
Dose-1	119	0.83	14:25	15:25	60	2.792	0.0561	0.0563
Dose-2	129	0.83	14:25	15:25	60	2.785	0.0559	(0.0005)
Dose-3	156	0.83	14:25	15:25	60	2.839	0.0570	
4-hr post-1	161	0.9	15:40	16:40	60	2.856	0.0529	0.0397
4-hr post-2	173	0.92	16:40	17:40	60	2.343	0.0425	(0.0089)
4-hr post-3	174	0.9	17:40	18:40	60	1.821	0.0337	
4-hr post-4	187	0.92	18:40	19:40	60	1.647	0.0298	
				Net Chal Level Conc:			0.0472	
				4-hr post Conc:			0.0397	

Location: Room 2 (Full sealing without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	204	0.93	13:35	14:05	30	0.243	0.0087	0.0100
Bkground-2	209	0.9	13:35	14:05	30	0.293	0.0109	(0.0009)
Bkground-3	210	0.92	13:35	14:05	30	0.284	0.0103	
Dose-1	230	0.9	14:25	15:25	60	1.092	0.0202	0.0203
Dose-2	237	0.93	14:25	15:25	60	1.085	0.0194	(0.0007)
Dose-3	252	0.9	14:25	15:25	60	1.139	0.0211	
4-hr post-1	293	0.89	15:40	16:40	60	1.681	0.0315	0.0301
4-hr post-2	298	0.88	16:40	17:40	60	1.581	0.0299	(0.0008)
4-hr post-3	301	0.9	17:40	18:40	60	1.599	0.0296	
4-hr post-4	303	0.88	18:40	19:40	60	1.551	0.0294	
				Net Chal Level Conc:			0.0103	
				4-hr post Conc:			0.0301	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	147	0.92	15:40	19:40	240	3.636	0.0165	0.0145
Bkground-2	181	0.9	15:40	19:40	240	3.657	0.0169	(0.0032)
Bkground-3	188	0.9	15:40	19:40	240	2.150	0.0100	

Avg Chal Conc: 5.111
Chal Dosage: 332.23

	Room 1	Room 2	Outer
Bkground Temp (°F)	89.6	87.9	86.9
Challenge Temp (°F)	92.7	89.1	85.3
4-hr post Temp (°F)	96.5	90.4	88.5

Trial MS-16 Methyl Salicylate Vapor Challenge Date: 10 July 96

Location: Room 1 (No sealing - with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	264	0.9	13:40	14:10	30	0.332	0.0123	0.0118
Bkground-2	268	0.95	13:40	14:10	30	0.320	0.0112	(0.0005)
Bkground-3	270	0.9	13:40	14:10	30	0.324	0.0120	
Dose-1	271	0.9	14:40	15:40	60	3.072	0.0569	0.0623
Dose-2	272	0.87	14:40	15:40	60	3.414	0.0654	(0.0039)
Dose-3	273	0.87	14:40	15:40	60	3.378	0.0647	
4-hr post-1	279	0.97	15:50	16:50	60	3.585	0.0616	0.0392
4-hr post-2	281	0.97	16:50	17:50	60	2.216	0.0381	(0.0138)
4-hr post-3	284	0.97	17:50	18:50	60	1.870	0.0321	
4-hr post-4	285	1	18:50	19:50	60	1.495	0.0249	
				Net Chal Level Conc:			0.0505	
				4-hr post Conc:			0.0392	

Location: Room 2 (No sealing - without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	288	0.92	13:40	14:10	30	0.353	0.0128	0.0121
Bkground-2	291	0.91	13:40	14:10	30	0.323	0.0118	(0.0005)
Bkground-3	292	0.92	13:40	14:10	30	0.320	0.0116	
Dose-1	295	0.93	14:40	15:40	60	3.792	0.0680	0.0683
Dose-2	296	0.92	14:40	15:40	60	3.812	0.0691	(0.0005)
Dose-3	297	0.89	14:40	15:40	60	3.629	0.0680	
4-hr post-1	299	0.89	15:50	16:50	60	5.457	0.1022	0.0889
4-hr post-2	300	0.87	16:50	17:50	60	4.633	0.0888	(0.0082)
4-hr post-3	347	0.9	17:50	18:50	60	4.506	0.0834	
4-hr post-4	384	0.84	18:50	19:50	60	4.086	0.0811	
				Net Chal Level Conc:			0.0563	
				4-hr post Conc:			0.0889	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	318	0.92	15:50	19:50	240	5.736	0.0260	0.0237
Bkground-2	319	0.92	15:50	19:50	240	5.777	0.0262	(0.0033)
Bkground-3	327	0.93	15:50	19:50	240	4.250	0.0190	

Avg Chal Conc: 4.966

Chal Dosage: 314.45

	Room 1	Room 2	Outer
Bkground Temp (°F)	87.4	84.3	81.9
Challenge Temp (°F)	90.5	85.7	82.8
4-hr post Temp (°F)	94.5	87.0	83.1

Trial MS-17 Methyl Salicylate Vapor Challenge Date: 11 July 96

Location: Room 1 (No sealing - without Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	306	0.9	13:55	14:25	30	0.238	0.0088	0.0099
Bkground-2	309	0.93	13:55	14:25	30	0.304	0.0109	(0.0009)
Bkground-3	314	0.9	13:55	14:25	30	0.270	0.0100	
Dose-1	315	0.87	14:30	15:30	60	2.981	0.0571	0.0593
Dose-2	316	0.87	14:30	15:30	60	3.327	0.0637	(0.0032)
Dose-3	320	0.9	14:30	15:30	60	3.073	0.0569	
4-hr post-1	321	1	15:50	16:50	60	5.690	0.0948	0.0734
4-hr post-2	323	1	16:50	17:50	60	4.663	0.0777	(0.0144)
4-hr post-3	324	0.97	17:50	18:50	60	3.693	0.0635	
4-hr post-4	334	1	18:50	19:50	60	3.460	0.0577	
				Net Chal Level Conc:			0.0493	
				4-hr post Conc:			0.0734	

Location: Room 2 (No sealing - with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	342	0.94	13:55	14:25	30	0.443	0.0157	0.0155
Bkground-2	355	0.86	13:55	14:25	30	0.408	0.0158	(0.0003)
Bkground-3	356	0.9	13:55	14:25	30	0.408	0.0151	
Dose-1	359	0.8	14:30	15:30	60	2.135	0.0445	0.0508
Dose-2	361	0.87	14:30	15:30	60	2.857	0.0547	(0.0045)
Dose-3	383	0.87	14:30	15:30	60	2.775	0.0532	
4-hr post-1	385	0.83	15:50	16:50	60	4.008	0.0805	0.0553
4-hr post-2	386	0.83	16:50	17:50	60	3.326	0.0668	(0.0195)
4-hr post-3	387	0.8	17:50	18:50	60	2.078	0.0433	
4-hr post-4	389	0.82	18:50	19:50	60	1.508	0.0307	
				Net Chal Level Conc:			0.0352	
				4-hr post Conc:			0.0553	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	336	0.93	15:50	19:50	240	2.491	0.0112	0.0131
Bkground-2	344	0.91	15:50	19:50	240	3.818	0.0175	(0.0031)
Bkground-3	345	0.9	15:50	19:50	240	2.276	0.0105	

			Room 1	Room 2	Outer
Avg Chal Conc:	4.919				
Chal Dosage:	295.12	Bkground Temp (°F)	82.1	--	83.7
		Challenge Temp (°F)	82.2	85.9	83.0
		4-hr post Temp (°F)	83.5	85.2	83.6

Trial MS-18   Methyl Salicylate Vapor Challenge   Date: 17 July 96

Location: Room 1 (Partial seal/vent fan only, with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	103	0.87	14:10	14:40	30	0.380	0.0146	0.0144
Bkground-2	105	0.91	14:10	14:40	30	0.419	0.0153	(0.0008)
Bkground-3	107	0.91	14:10	14:40	30	0.367	0.0134	
Dose-1	122	0.87	15:15	16:15	60	3.094	0.0593	0.0594
Dose-2	139	0.87	15:15	16:15	60	3.012	0.0577	(0.0015)
Dose-3	140	0.87	15:15	16:15	60	3.203	0.0614	
4-hr post-1	149	0.97	16:25	17:25	60	3.168	0.0544	0.0361
4-hr post-2	157	0.95	17:25	18:25	60	1.946	0.0341	(0.0109)
4-hr post-3	163	0.97	18:25	19:25	60	1.725	0.0296	
4-hr post-4	169	0.97	19:25	20:25	60	1.527	0.0262	
				Net Chal Level Conc:			0.0450	
				4-hr post Conc:			0.0361	

Location: Room 2 (Partial seal/vent fan only, no Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	414	0.94	14:10	14:40	30	0.433	0.0153	0.0149
Bkground-2	436	0.89	14:10	14:40	30	0.396	0.0148	(0.0003)
Bkground-3	437	0.85	14:10	14:40	30	0.371	0.0146	
Dose-1	438	0.85	15:15	16:15	60	3.511	0.0688	0.0668
Dose-2	440	0.85	15:15	16:15	60	3.498	0.0686	(0.0027)
Dose-3	441	0.84	15:15	16:15	60	3.175	0.0630	
4-hr post-1	443	0.83	16:25	17:25	60	4.154	0.0834	0.0650
4-hr post-2	480	0.83	17:25	18:25	60	3.190	0.0641	(0.0112)
4-hr post-3	483	0.87	18:25	19:25	60	2.989	0.0573	
4-hr post-4	485	0.85	19:25	20:25	60	2.811	0.0551	
				Net Chal Level Conc:			0.0519	
				4-hr post Conc:			0.0650	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	250	0.97	16:25	20:25	240	3.608	0.0155	0.0164
Bkground-2	265	0.97	16:25	20:25	240	5.218	0.0224	(0.0046)
Bkground-3	290	0.97	16:25	20:25	240	2.597	0.0112	

Avg Chal Conc: 5.589
Chal Dosage: 335.36

	Room 1	Room 2	Outer
Bkground Temp (°F)	88.5	87.3	89.2
Challenge Temp (°F)	92.6	88.0	88.0
4-hr post Temp (°F)	97.0	89.8	88.5

Trial MS-19 Methyl Salicylate Vapor Challenge Date: 18 July 96

Location: Room 1 (Partial seal/vent fan only, no Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	102	0.87	13:55	14:25	30	0.528	0.0202	0.0210
Bkground-2	106	0.89	13:55	14:25	30	0.580	0.0217	(0.0006)
Bkground-3	109	0.91	13:55	14:25	30	0.571	0.0209	
Dose-1	119	0.87	14:40	15:40	60	3.034	0.0581	0.0593
Dose-2	129	0.87	14:40	15:40	60	3.269	0.0626	(0.0024)
Dose-3	156	0.87	14:40	15:40	60	2.984	0.0572	
4-hr post-1	161	0.96	15:50	16:50	60	4.614	0.0801	0.0673
4-hr post-2	173	0.96	16:50	17:50	60	4.011	0.0696	(0.0093)
4-hr post-3	174	0.96	17:50	18:50	60	3.754	0.0652	
4-hr post-4	187	0.97	18:50	19:50	60	3.157	0.0542	
				Net Chal Level Conc:			0.0384	
				4-hr post Conc:			0.0673	

Location: Room 2 (Max sealing: vent/window/door, with Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	204	0.94	13:55	14:25	30	0.544	0.0193	0.0195
Bkground-2	209	0.92	13:55	14:25	30	0.548	0.0198	(0.0002)
Bkground-3	210	0.94	13:55	14:25	30	0.549	0.0195	
Dose-1	230	0.92	14:40	15:40	60	1.444	0.0262	0.0260
Dose-2	237	0.94	14:40	15:40	60	1.446	0.0256	(0.0002)
Dose-3	252	0.91	14:40	15:40	60	1.426	0.0261	
4-hr post-1	293	0.9	15:50	16:50	60	1.883	0.0349	0.0230
4-hr post-2	298	0.89	16:50	17:50	60	1.122	0.0210	(0.0071)
4-hr post-3	304	0.9	17:50	18:50	60	1.082	0.0200	
4-hr post-4	305	0.9	18:50	19:50	60	0.866	0.0160	
				Net Chal Level Conc:			0.0064	
				4-hr post Conc:			0.0230	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m^3	Avg Conc (Std Dev) mg/m^3
Bkground-1	250	0.97	15:50	19:50	240	3.608	0.0155	0.0164
Bkground-2	265	0.97	15:50	19:50	240	5.218	0.0224	(0.0046)
Bkground-3	290	0.97	15:50	19:50	240	2.597	0.0112	

Avg Chal Conc: 5.031
Chal Dosage: 326.98

	Room 1	Room 2	Outer
Bkground Temp (°F)	87.9	88.5	84.8
Challenge Temp (°F)	88.6	92.2	84.7
4-hr post Temp (°F)	88.8	95.1	80.3

Trial MS-20 Methyl Salicylate Vapor Challenge Date: 19 July 96

Location: Room 1 (Partial seal/vent fan only, no Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	120	0.87	10:10	10:40	30	0.626	0.0240	0.0216
Bkground-2	165	0.77	10:10	10:40	30	0.405	0.0175	(0.0029)
Bkground-3	166	0.85	10:10	10:40	30	0.592	0.0232	
Dose-1	167	0.83	11:00	12:00	60	3.436	0.0690	0.0678
Dose-2	170	0.86	11:00	12:00	60	3.473	0.0673	(0.0009)
Dose-3	172	0.88	11:00	12:00	60	3.535	0.0669	
4-hr post-1	176	0.97	12:20	13:20	60	4.685	0.0805	0.0705
4-hr post-2	179	0.97	13:20	14:20	60	4.043	0.0695	(0.0060)
4-hr post-3	205	0.95	14:20	15:20	60	3.822	0.0671	
4-hr post-4	206	0.98	15:20	16:20	60	3.816	0.0649	
				Net Chal Level Conc:			0.0462	
				4-hr post Conc:			0.0705	

Location: Room 2 (Partial seal/vent fan only, no Recirculation Filter)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	226	0.9	10:10	10:40	30	0.608	0.0225	0.0215
Bkground-2	240	0.93	10:10	10:40	30	0.568	0.0204	(0.0009)
Bkground-3	243	0.94	10:10	10:40	30	0.612	0.0217	
Dose-1	258	0.95	11:00	12:00	60	3.283	0.0576	0.0569
Dose-2	261	0.97	11:00	12:00	60	3.293	0.0566	(0.0005)
Dose-3	262	0.95	11:00	12:00	60	3.222	0.0565	
4-hr post-1	263	0.93	12:20	13:20	60	4.129	0.0740	0.0655
4-hr post-2	269	0.9	13:20	14:20	60	3.641	0.0674	(0.0057)
4-hr post-3	302	0.93	14:20	15:20	60	3.296	0.0591	
4-hr post-4	489	0.87	15:20	16:20	60	3.219	0.0617	
				Net Chal Level Conc:			0.0354	
				4-hr post Conc:			0.0655	

Location: Shop Area (Residual Background)

Sampling Position	Tube	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	MS Conc mg/m³	Avg Conc (Std Dev) mg/m³
Bkground-1	215	0.9	12:20	16:20	240	3.608	0.0167	0.0169
Bkground-2	219	0.95	12:20	16:20	240	5.218	0.0229	(0.0048)
Bkground-3	220	0.97	12:20	16:20	240	2.597	0.0112	

			Room 1	Room 2	Outer
Avg Chal Conc:	5.138				
Chal Dosage:	318.56	Bkground Temp (°F)	83.4	86.3	78.2
		Challenge Temp (°F)	84.7	87.1	81.2
		4-hr post Temp (°F)	85.8	87.2	82.0

Trial GB-4 Sheltering-In-Place GB Vapor Challenge Date: 11-12 Sep 97

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.05	9:50	10:20	30	0.004	0.00252	0.08	0.054
Bkground 2	0.065	9:50	10:20	30	0.003	0.00148	0.04	(0.016)
Bkground 3	0.065	9:50	10:20	30	0.003	0.00135	0.04	
Challenge 1	0.045	11:14	12:30	75.8	0.420	0.12308	9.33	8.556
Challenge 2	0.035	11:14	12:30	75.8	0.350	0.13187	10.00	(1.60)
Challenge 3	0.03	11:14	12:30	75.8	0.190	0.08352	6.33	
4-hr post 1	0.09	12:33	16:30	237	2.500	0.11721	27.78	23.80
4-hr post 2	0.07	12:33	16:30	237	0.720	0.04340	10.29	(9.82)
4-hr post 3	0.075	12:33	16:30	237	2.500	0.14065	33.33	
8-hr post 1	0.1	16:30	00:30	480	1.800	0.03749	18.00	19.40
8-hr post 2	0.065	16:30	00:30	480	1.400	0.04486	21.54	(1.54)
8-hr post 3	0.075	16:30	00:30	480	1.400	0.03888	18.67	
12-hr post 1	0.1	00:30	12:30	720	1.100	0.01528	11.00	16.39
12-hr post 2	0.065	00:30	12:30	720	1.070	0.02286	16.46	(4.37)
12-hr post 3	0.05	00:30	12:30	720	1.085	0.03014	21.70	

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.045	09:50	10:20	30	0.006	0.00430	0.13	0.242
Bkground 2	0.025	09:50	10:20	30	0.006	0.00800	0.24	(0.093)
Bkground 3	0.04	09:50	10:20	30	0.014	0.01187	0.36	
Challenge 1	0.08	11:14	12:30	75.8	1.800	0.29670	22.50	24.64
Challenge 2	0.07	11:14	12:30	75.8	1.800	0.33909	25.71	(1.52)
Challenge 3	0.07	11:14	12:30	75.8	1.800	0.33909	25.71	
4-hr post 1	0.045	12:33	04:30	237	2.800	0.26254	62.22	50.26
4-hr post 2	0.07	12:33	04:30	237	3.200	0.19289	45.71	(8.54)
4-hr post 3	0.07	12:33	04:30	237	3.000	0.18083	42.86	
8-hr post 1	0.045	04:30	12:30	480	2.000	0.09258	44.44	40.21
8-hr post 2	0.055	04:30	12:30	480	2.100	0.07953	38.18	(2.99)
8-hr post 3	0.05	04:30	12:30	480	1.900	0.07915	38.00	
12-hr post 1	0.055	12:30	12:30	720	0.860	0.02172	15.64	16.15
12-hr post 2	0.08	12:30	12:30	720	1.200	0.02083	15.00	(1.20)
12-hr post 3	0.05	12:30	12:30	720	0.890	0.02472	17.80	

Avg Challenge Concentration: 6.50 mg/m^3 (top 6.29 mg/m^3 ; center 6.72 mg/m^3)
Challenge Dosage: 493 mg-min/m^3 (75.8 minutes)

Trial GB-5 Sheltering-In-Place GB Vapor Challenge Date: 18-19 Sep 97

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m^3	Dosage, Mean, STD $mg\text{-}min/m^3$	
Bkground 1	0.05	10:05	10:35	30	0.004	0.00252	0.08	0.055
Bkground 2	0.06	10:05	10:35	30	0.003	0.00160	0.05	(0.015)
Bkground 3	0.065	10:05	10:35	30	0.003	0.00135	0.04	
Challenge 1	0.03	11:40	12:45	65	0.360	0.18462	12.00	12.87
Challenge 2	0.03	11:40	12:45	65	0.370	0.18974	12.33	(1.01)
Challenge 3	0.035	11:40	12:45	65	0.500	0.21978	14.29	
4-hr post 1	0.09	12:45	16:45	240	2.800	0.12963	31.11	31.43
4-hr post 2	0.065	12:45	16:45	240	2.300	0.14744	35.38	(3.11)
4-hr post 3	0.09	12:45	16:45	240	2.500	0.11574	27.78	
8-hr post 1	0.08	16:45	00:45	480	2.100	0.05468	26.25	25.22
8-hr post 2	0.07	16:45	00:45	480	1.900	0.05654	27.14	(2.14)
8-hr post 3	0.09	16:45	00:45	480	2.000	0.04629	22.22	
12-hr post 1	0.065	00:45	12:45	720	0.940	0.02009	14.46	15.64
12-hr post 2	0.075	00:45	12:45	720	1.200	0.02222	16.00	(0.86)
12-hr post 3	0.085	12:45	12:45	720	1.400	0.02288	16.47	

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m^3	Dosage, Mean, STD $mg\text{-}min/m^3$	
Bkground 1	0.025	10:05	10:35	30	0.006	0.00773	0.23	0.286
Bkground 2	0.04	10:05	10:35	30	0.006	0.00500	0.15	(0.14)
Bkground 3	0.03	10:05	10:35	30	0.014	0.01582	0.47	
Challenge 1	0.055	11:40	12:45	65	1.500	0.41958	27.27	26.31
Challenge 2	0.06	11:40	12:45	65	1.600	0.41026	26.67	(0.96)
Challenge 3	0.08	11:40	12:45	65	2.000	0.38462	25.00	
4-hr post 1	0.06	12:45	16:45	240	2.800	0.1944	46.67	44.3
4-hr post 2	0.05	12:45	16:45	240	2.500	0.20833	50.00	(5.86)
4-hr post 3	0.08	12:45	16:45	240	2.900	0.15104	36.25	
8-hr post 1	0.055	16:45	00:45	480	2.000	0.07574	36.36	38.92
8-hr post 2	0.045	16:45	00:45	480	1.900	0.08795	42.22	(2.45)
8-hr post 3	0.055	16:45	00:45	480	2.100	0.07953	38.18	
12-hr post 1	0.07	00:45	12:45	720	1.100	0.02183	15.71	17.0
12-hr post 2	0.06	00:45	12:45	720	1.100	0.02546	18.33	(1.07)
12-hr post 3	0.065	12:45	12:45	720	1.100	0.02350	16.92	

Avg Challenge Concentration: 7.61 mg/m^3 (top 7.74 mg/m^3 ; center 7.49 mg/m^3)
Challenge Dosage: 495 $mg\text{-}min/m^3$

	Room 1	Room 2	Chamber1	Chamber 2
Background Temp (°F)	79-86	81-84	78	76
Challenge Temp (°F)	86-89	84-87	79	78
Residual Temp (°F)	89-96	87-92	70-81	67-79

Trial GB-6 **Sheltering-In-Place GB Vapor Challenge** **Date: 9-10 Oct 97**

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m³	Dosage, Mean, STD mg-min/m³
Bkground 1	0.06	11:12	11:42	30	0.000	0.00000	0.00 0.000
Bkground 2	0.06	11:12	11:42	30	0.000	0.00000	0.00 (0.000)
Bkground 3	0.065	11:12	11:42	30	0.000	0.00000	0.00
Challenge 1	0.04	12:15	13:20	65	0.340	0.13077	8.50 6.806
Challenge 2	0.04	12:15	13:20	65	0.290	0.11154	7.25 (1.596)
Challenge 3	0.03	12:15	13:20	65	0.140	0.07179	4.67
4-hr post 1	0.075	13:20	17:20	240	2.900	0.16111	38.7 35.98
4-hr post 2	0.08	13:20	17:20	240	3.000	0.15625	37.5 (3.02)
4-hr post 3	0.085	13:20	17:20	240	2.700	0.13235	31.76
8-hr post 1	0.075	17:20	01:20	480	2.300	0.06388	30.67 29.4
8-hr post 2	0.085	17:20	01:20	480	2.500	0.06126	29.41 (0.99)
8-hr post 3	0.085	17:20	01:20	480	2.400	0.05881	28.24
12-hr post 1	0.075	01:20	13:20	720	1.500	0.02778	20.00 21.73
12-hr post 2	0.095	01:20	13:20	720	1.700	0.02485	17.89 (4.02)
12-hr post 3	0.055	01:20	13:20	720	1.500	0.03788	27.27

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	GB Conc mg/m³	Dosage, Mean, STD mg-min/m³
Bkground 1	0.025	11:12	11:42	30	0.000	0.00000	0.00 0.000
Bkground 2	0.025	11:12	11:42	30	0.000	0.00000	0.00 (0.000)
Bkground 3	0.03	11:12	11:42	30	0.000	0.00000	0.00
Challenge 1	0.065	12:15	13:20	65	2.200	0.5207	33.85 28.73
Challenge 2	0.05	12:15	13:20	65	1.200	0.3692	24.00 (4.029)
Challenge 3	0.06	12:15	13:20	65	1.700	0.4359	28.33
4-hr post 1	0.06	13:20	17:20	240	3.600	0.2500	60.00 57.35
4-hr post 2	0.06	13:20	17:20	240	3.400	0.2361	56.67 (1.95)
4-hr post 3	0.065	13:20	17:20	240	3.600	0.2308	55.38
8-hr post 1	0.045	17:20	01:20	480	2.100	0.0972	46.67 42.96
8-hr post 2	0.06	17:20	01:20	480	2.400	0.0833	40.00 (2.77)
8-hr post 3	0.045	17:20	01:20	480	1.900	0.0879	42.22
12-hr post 1	0.07	01:20	01:20	720	0.740	0.0147	10.57 11.61
12-hr post 2	0.075	01:20	13:20	720	0.870	0.0161	11.60 (0.86)
12-hr post 3	0.045	01:20	13:20	720	0.570	0.0176	12.67

Avg Challenge Concentration: 5.67 mg/m³ (top 5.63 mg/m³ ; center 5.70 mg/m³)
Challenge Dosage: 368 mg-min/m³

	Room 1	Room 2	Chamber 1	Chamber 2
Bkground Temp (°F)	76-86	81-84	74-75	72-74
Challenge Temp (°F)	80-84	81-85	76	76
Residual Temp (°F)	84-91	85-91	77-79	76-79

Trial HD-1 Sheltering-In-Place HD Vapor Challenge Date: 13-14 Nov 97

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	HD Conc mg/m³	Dosage, Mean, STD mg-min/m³	
Bkground 1	0.06	09:16	09:52	36.5	0.000	0.00000	0.00	0.000
Bkground 2	0.075	09:16	09:52	36.5	0.000	0.00000	0.00	(0.000)
Bkground 3	0.05	09:16	09:52	36.5	0.000	0.00000	0.00	
Challenge 1	0.07	10:55	12:02	67	0.014	0.00299	0.20	0.243
Challenge 2	0.06	10:55	12:02	67	0.010	0.00249	0.17	(0.086)
Challenge 3	0.055	10:55	12:02	67	0.020	0.00543	0.36	
4-hr post 1	0.11	12:03	16:03	240	0.560	0.02121	5.09	4.854
4-hr post 2	0.045	12:03	16:03	240	0.190	0.01759	4.22	(0.452)
4-hr post 3	0.08	12:03	16:03	240	0.420	0.02188	5.25	
8-hr post 1	0.065	16:03	00:03	480	0.073	0.00234	1.12	1.277
8-hr post 2	0.08	16:03	00:03	480	0.110	0.00286	1.38	(0.106)
8-hr post 3	0.1	16:03	00:03	480	0.130	0.00271	1.30	
12-hr post 1	0.08	00:03	12:03	720	0.044	0.00076	0.55	0.714
12-hr post 2	0.07	00:03	12:03	720	0.045	0.00089	0.64	(0.171)
12-hr post 3	0.06	00:03	12:03	720	0.057	0.00132	0.95	

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	HD Conc mg/m³	Dosage, Mean, STD mg-min/m³	
Bkground 1	0.025	09:16	09:52	36.5	0.000	0.00000	0.00	0.000
Bkground 2	0.02	09:16	09:52	36.5	0.000	0.00000	0.00	(0.000)
Bkground 3	0.025	09:16	09:52	36.5	0.000	0.00000	0.00	
Challenge 1	0.04	10:55	12:02	67	0.057	0.02127	1.43	1.527
Challenge 2	0.06	10:55	12:02	67	0.056	0.01393	0.93	(0.531)
Challenge 3	0.045	10:55	12:02	67	0.100	0.03317	2.22	
4-hr post 1	0.03	12:03	16:03	240	0.180	0.02500	6.00	6.444
4-hr post 2	0.06	12:03	16:03	240	0.410	0.02847	6.83	(0.343)
4-hr post 3	0.06	12:03	16:03	240	0.390	0.02708	6.50	
8-hr post 1	0.025	16:03	00:03	480	0.053	0.00442	2.12	3.018
8-hr post 2	0.05	16:030	00:03	480	0.180	0.00750	3.60	(0.644)
8-hr post 3	0.045	16:03	00:03	480	0.150	0.00694	3.33	
12-hr post 1	0.035	00:03	12:03	720	0.031	0.00123	0.89	1.230
12-hr post 2	0.06	00:03	12:03	720	0.083	0.00192	1.38	(0.244)
12-hr post 3	0.05	00:03	12:03	720	0.071	0.00197	1.42	

Avg Challenge Concentration: 5.93 mg/m³
Challenge Dosage: 397 mg-min/m³

<u>Temperatures:</u>

Room 1	68-85°F
Room 2	69-86°F
Chamber low	69-73°F
Chamber high	70-73°F

Trial HD-2 Sheltering-In-Place HD Vapor Challenge Date: 18-19 Nov 97

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	HD Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.05	09:45	10:15	30	0.004	0.00267	0.08	0.027
Bkground 2	0.06	09:45	10:15	30	0.000	0.00000	0.00	(0.038)
Bkground 3	0.055	09:45	10:15	30	0.000	0.00000	0.00	
Challenge 1	0.045	11:13	12:25	72.3	0.063	0.01935	1.40	0.582
Challenge 2	0.055	11:13	12:25	72.3	0.014	0.00352	0.25	(0.582)
Challenge 3	0.055	11:13	12:25	72.3	0.005	0.00126	0.09	
4-hr post 1	0.045	12:25	16:25	239.3	0.200	0.01857	4.44	4.070
4-hr post 2	0.085	12:25	16:25	239.3	0.310	0.01524	3.65	(0.327)
4-hr post 3	0.085	12:25	16:25	239.3	0.350	0.01721	4.12	
8-hr post 1	0.065	04:25	12:25	480.1	0.099	0.00317	1.52	1.746
8-hr post 2	0.07	04:25	12:25	480.1	0.120	0.00357	1.71	(0.196)
8-hr post 3	0.085	04:25	12:25	480.1	0.170	0.00417	2.00	
12-hr post 1	0.065	12:25	12:25	720	0.034	0.00073	0.52	0.667
12-hr post 2	0.075	12:25	12:25	720	0.054	0.00100	0.72	(0.103)
12-hr post 3	0.07	12:25	12:25	720	0.053	0.00105	0.76	

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Time Off	Total Time (min)	Mass (ug)	HD Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.04	09:45	10:15	30	0.000	0.00000	0.00	0.000
Bkground 2	0.035	09:45	10:15	30	0.000	0.00000	0.00	(0.000)
Bkground 3	0.025	09:45	10:15	30	0.000	0.00000	0.00	
Challenge 1	0.065	11:13	12:25	72	0.027	0.00577	0.42	0.898
Challenge 2	0.065	11:13	12:25	72	0.056	0.01197	0.86	(0.410)
Challenge 3	0.055	11:13	12:25	72	0.078	0.01970	1.42	
4-hr post 1	0.055	12:25	16:25	240	0.560	0.04242	10.18	7.359
4-hr post 2	0.055	12:25	16:25	240	0.370	0.02803	6.73	(2.096)
4-hr post 3	0.06	12:25	16:25	240	0.310	0.02153	5.17	
8-hr post 1	0.045	16:25	00:25	480.1	0.200	0.00926	4.44	5.185
8-hr post 2	0.06	16:25	00:25	480.1	0.200	0.00694	3.33	(1.889)
8-hr post 3	0.045	16:25	00:25	480.1	0.350	0.01620	7.78	
12-hr post 1	0.07	00:25	12:25	720	0.060	0.00119	0.86	2.069
12-hr post 2	0.045	00:25	12:25	720	0.130	0.00401	2.89	(0.875)
12-hr post 3	0.065	00:25	12:25	720	0.160	0.00342	2.46	

Avg Challenge Concentration: 5.61 mg/m^3
Challenge Dosage: 383 mg-min/m^3

Temperatures:

Room 1	80-82°F
Room 2	80-82°F
Chamber low	61-63°F
Chamber high	63-65°F

Trial HD-3 Sheltering-In-Place HD Vapor Challenge Date: 20-21 Nov 97

Location: Room 1 (single window)

Sampling Position	Flowrate (ℓ/min)	Time On	Total Time Off	Time (min)	Mass (ug)	HD Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.05	07:42	08:12	30	0.000	0.00000	0.00	0.000
Bkground 2	0.065	07:42	08:12	30	0.000	0.00000	0.00	(0.000)
Bkground 3	0.045	07:42	08:12	30	0.000	0.00000	0.00	
Challenge 1	0.03	08:35	09:41	66	0.015	0.00758	0.50	0.484
Challenge 2	0.03	08:35	09:41	66	0.013	0.00657	0.43	(0.037)
Challenge 3	0.025	08:35	09:41	66	0.013	0.00788	0.52	
4-hr post 1	0.065	09:41	13:41	240	0.200	0.01282	3.08	2.711
4-hr post 2	0.06	09:41	13:41	240	0.170	0.01181	2.83	(0.360)
4-hr post 3	0.09	09:41	13:41	240	0.200	0.00926	2.22	
8-hr post 1	0.05	13:41	21:41	480	0.067	0.00279	1.34	1.187
8-hr post 2	0.08	13:41	21:41	480	0.160	0.00417	2.00	(0.734)
8-hr post 3	0.09	13:41	21:41	480	0.020	0.00046	0.22	
12-hr post 1	0.065	21:41	09:41	720	0.040	0.00085	0.62	0.619
12-hr post 2	0.065	21:41	09:41	720	0.043	0.00092	0.66	(0.033)
12-hr post 3	0.05	21:41	09:41	720	0.029	0.00081	0.58	

Location: Room 2 (two windows)

Sampling Position	Flowrate (ℓ/min)	Time On	Total Time Off	Time (min)	Mass (ug)	HD Conc mg/m^3	Dosage, Mean, STD mg-min/m^3	
Bkground 1	0.03	07:42	08:12	30	0.000	0.00000	0.00	0.000
Bkground 2	0.03	07:42	08:12	30	0.000	0.00000	0.00	(0.000)
Bkground 3	0.025	07:42	08:12	30	0.000	0.00000	0.00	
Challenge 1	0.06	08:35	09:41	66	0.083	0.02096	1.38	1.295
Challenge 2	0.085	08:35	09:41	66	0.100	0.01783	1.18	(0.087)
Challenge 3	0.04	08:35	09:41	66	0.053	0.02008	1.33	
4-hr post 1	0.055	09:41	13:41	240	0.245	0.01856	4.45	4.788
4-hr post 2	0.065	09:41	13:41	240	0.325	0.02083	5.00	(0.239)
4-hr post 3	0.055	09:41	13:41	240	0.270	0.02045	4.91	
8-hr post 1	0.04	13:41	21:41	480	0.145	0.00755	3.63	3.558
8-hr post 2	0.04	13:41	21:41	480	0.090	0.00469	2.25	(1.042)
8-hr post 3	0.05	13:41	21:41	480	0.240	0.01000	4.80	
12-hr post 1	0.05	21:41	09:41	720	0.084	0.00233	1.68	1.137
12-hr post 2	0.055	21:41	09:41	720	0.081	0.00205	1.47	(0.628)
12-hr post 3	0.07	21:41	09:41	720	0.018	0.00036	0.26	

Avg Challenge Concentration: 5.71 mg/m^3
Challenge Dosage: 377 mg-min/m^3

Temperatures:

Room 1	72-83°F
Room 2	73-84°F
Chamber low	64-68°F
Chamber high	65-70°F